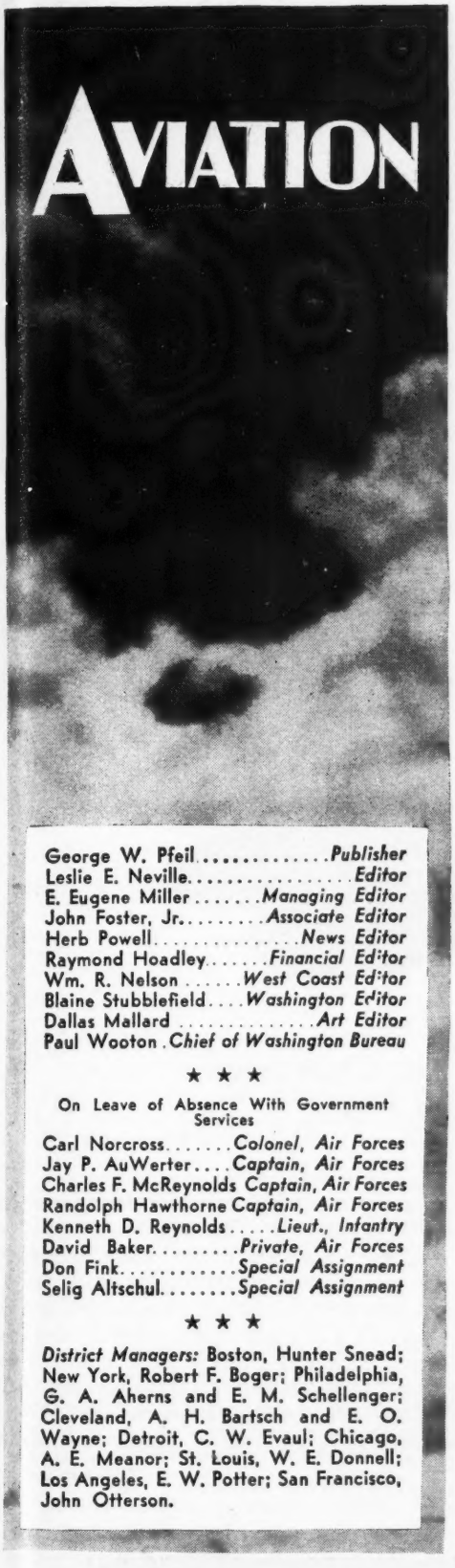

March, 1944

Volume 43 • Number 3

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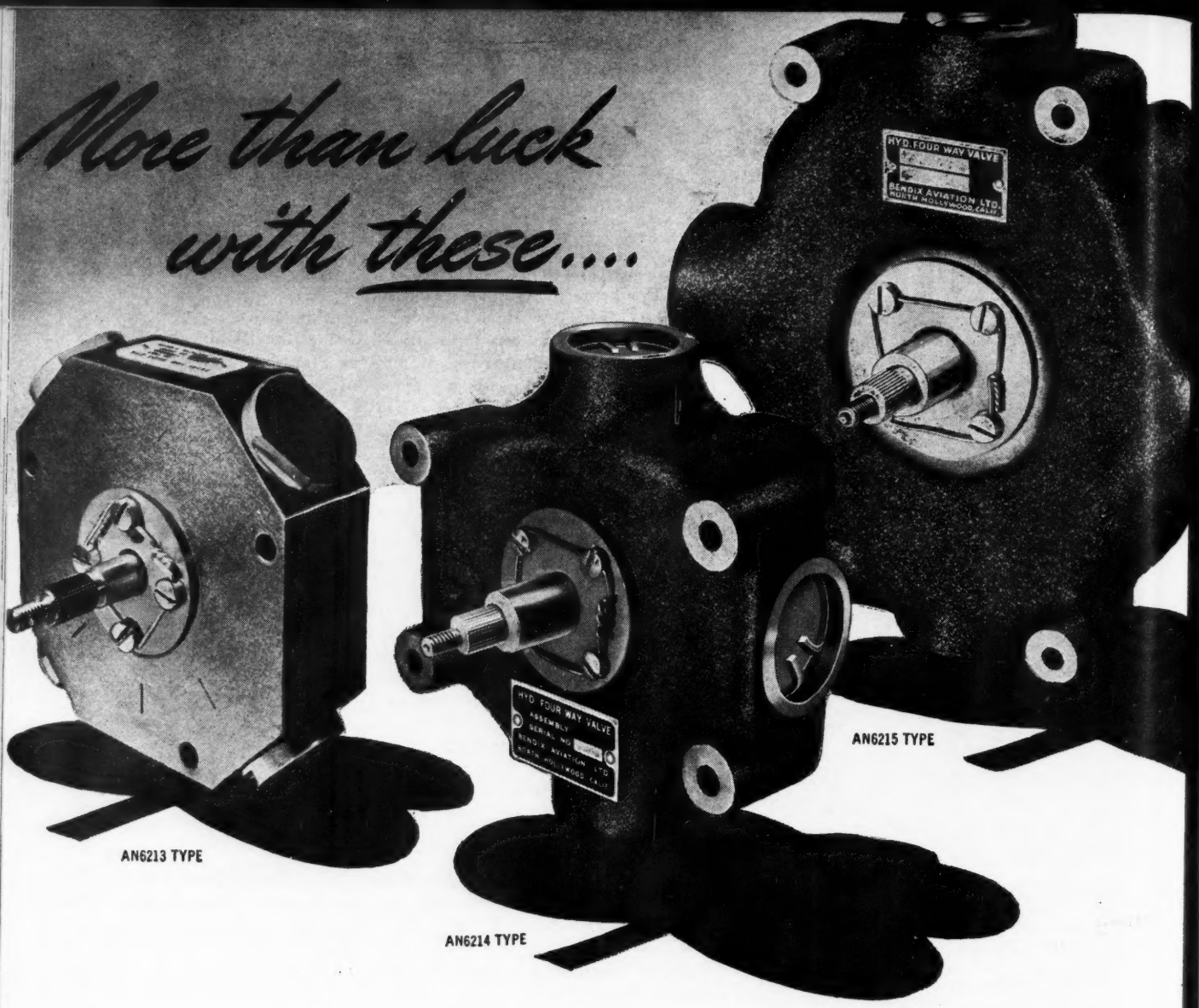
More than luck with these....



Four-Leaf Clovers

These Altair* Four-Way Selector Valves are often spoken of as "four-leaf clovers."

It was no lucky coincidence, however, that determined the characteristic shape of these AN valves. Their radial design was deliberately planned to achieve –

Least cubic volume and weight per square inch of port area.

Lowest pressure drop because fluid path is shortest.

Greatest simplicity to speed volume manufacture.

In addition, only these selector valves incorporate the proven Altair Plastic Poppets.† This combination of advantages has earned for Altair valves their record of performance and easy maintenance under the toughest jobs of war. Complete data on Altair Selector Valves – 1/4 to 3/4 tube size in single, dual or triple banks – will be sent to air frame engineering personnel on request. Pacific Division, Bendix Aviation Corporation, North Hollywood. Sales Engineering offices in St. Louis, Dayton and New York.

**The new trade name of Pacific Division, Bendix Aviation Corp.*

†Patents Pending

Altair Four-Way Valves now are being supplied on 24 different types of military aircraft, controlling virtually every function of hydraulic operation.

Pacific Division
Bendix Aviation Corporation
(Formerly Bendix Aviation, Ltd.)
NORTH HOLLYWOOD, CALIF.

Bendix Aviation Corporation

DESIGNERS AND MANUFACTURERS OF RADIO AND HYDRAULIC EQUIPMENT — OUR PART OF THE INVISIBLE

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Briefing for March

R. W. Gemmel (left) and **J. C. Cunningham** (right), of Westinghouse Electric & Mfg. Co., whose important article on alternating current distribution systems in high altitude aircraft appears on page 138.

Two very important articles in this issue present the first concrete and specific plans for postwar reconversion activity by representative members of the existing aviation industry. The Northrop plan, detailed on page 108 by **LaMotte T. Cohu,** board chairman & general manager, is a courageous and practical program designed to provide aircraft workers with full time earning activities through the war-to-peace transition period. This program involves a careful survey of the workers' skills and a realistic and a dynamic program of job placement. Provided in the article is much food for thought for all aircraft manufacturers.

In our second reconversion article (page 110), **Earl M. Scott,** president of Scott Aviation Corp., presents a plan to solve the reconversion problems of small war plants without seeking government charity. The problems faced by Scott's company are common to literally thousands of war plants throughout the country, and his forthright approach to a solution which is fully within the bounds of sound economies should be of prime interest to the industry and its legislative bodies.

Results of the East Coast Aircraft War Production Council's manpower utilization survey shows that the average worker productivity has increased over 80 percent. Much of this "up" has been the result of the employees' own head work in achieving greater output at an accelerated rate and at lower costs. Page 112.

The so-called V and VT loan measures, which fell short of giving war contractors proper assistance through the difficult days of contract termination, will probably be succeeded by the new Baruch-sponsored T loans. Financial Editor Hoadley analyzes the T loan on page 115.

Aviation's noted design analysis series continues in this issue with No. 6—the Bristol *Beaufighter*. This is the first time that a foreign airplane has been revealed in such comprehensive detail. The unusually complete text meticulously describes the structural details of this versatile aircraft, and AVIATION'S renowned sketchbook technique has been employed lavishly to depict the structural components in their finest detail. Page 117.

Thicknesses of propeller blades has never been satisfactorily determined by sectioning and caliper methods. **H. P. Moyer** of American Propeller Corp. describes the application of X-Rays to accurately calculate thicknesses of complete propellers. His article begins on page 147.

Greater efficiency in the solution of complex wing layout problems is now achieved by simple mathematics utilizing analytical geometry. **R. W. Feeny** describes method on page 148.

Down the Years in AVIATION'S Log

25 Yr. Ago (1919)—Engineers prophecy that 200 mph. flight will soon be realized commercially. . . . War Dept. discloses design for successfully tested self-sealing fuel tank. . . . French authority states that pilots reject 80 percent of propellers after test due to lack of balance. . . . Manufacturers' Aircraft Assn. opens first annual Aeronautical Exposition at Madison Square Garden. . . . Joint Army and Navy board issues civilian flying licenses. . . . United Aircraft Engineering Corp. buys $10,000,000 worth of British Government aircraft materials. . . . Cascade National Forest uses ten planes for fire patrol. . . . Navy exhibits 103-ft. span flying boat with cannon and 11 machine guns.

15 Yr. Ago (1929)—AVIATION completes 13th year and becomes McGraw-Hill magazine. . . . Packard starts construction of aircraft diesel engine factory. . . . Haldeman and Hayden fly non-stop from Canada to Cuba, . . . Union Air Lines orders three 16-passenger Douglas flying boats for new Seattle-Alaska route. . . . Mexican Aviation Co. buys Ford Trimotor for service between Brownsville, Merida, and Yucatan. . . . Michigan proposes tax on airplane gasoline to finance new airports. . . . Post Office now carries 480,000 lb. of airmail monthly over 26 airlines. . . . first aviation mechanic license given to a woman goes to Lady Mary Heath, together with transport pilot license. . . . Barney Oldfield announces Los Angeles-Mexico City airline. . . . Grand Central Air Terminal opened at Glendale, Cal. . . . Pittsburgh airport enlarged from 65 to 185 acres. . . . Chicago Great Western R. R. and Universal Air Lines announce through air-rail tickets from Minneapolis east.

10 Yr. Ago (1934) Airline speeds average 150 mph. . . . New York-Washington air passengers equal 10 percent of Pullman travel over same route. . . . Airline operation volume increased 50 percent in year with 15 percent fewer planes. . . . Post Office announces over 7,000,000 lb. airmail carried in '33. . . . Airlines average over 150,000 plane-miles per day. . . . PAA opens International Marine Airport at Miami. . . . British Air Ministry sets aside 13 practice areas for "cloud flying." . . . Comdr. Frank Hawks demonstrates Curtiss *Condor* bomber to Chinese Gov't. . . . Senate approves bill authorizing 1,184 planes and new aircraft carrier. . . .McSwain Bill proposes separate Air Corps having 5,559 officers, 32,804 enlisted men, and 4,834 planes.

THE KOLLSMAN MARK VI DRIFT SIGHT is a worthy companion to the regular Kollsman line of aircraft instruments. It is used for an accurate determination of drift and ground speed on Navy long range aircraft. Exclusively Kollsman designed, engineered and manufactured... even to the lenses and prisms in its fine optical system... it gives new evidence of Kollsman's versatility in adapting its talents to almost any type of precision engineering problem.

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Industry Must Lead In Re-Locating Workers

AMERICAN INDUSTRY has proved beyond a shadow of doubt that it can produce anything in any quantity with ever increasing efficiency and ease. Given the necessary materials, manpower, and machines at the proper time and place and the volume of product is readily predictable. The responsibility of creating worldly goods has been carried willingly and ably by industry. Now we are entering a new phase of the industrial revolution. Broader responsibilities for industry lie immediately ahead.

No longer will the common man accept a doctrine that penalizes him with unemployment because he has produced too much or too well. Industry must decide whether it is willing to assume the responsibility for continuous employment for its workers or whether this responsibility is to be turned over to government. It should be obvious to the practical manufacturer that the smaller the degree of government assistance, the better will be the result.

The ideal solution would be for industry to strike out boldly and solve the problem as it has solved many others contributing to the brilliant achievements of the enterprise system. Any other course will completely undermine this system.

It is folly to advocate that a plant continue to operate after the demand for its products has waned. It would be financially impossible for most aviation plants to continue after total cancellation without wiping out their capital in a few days. But there are several steps that can be taken to plan for the preservation of the continued livelihood of the workers if that objective is given primary emphasis in management's thinking.

FIRST STEP is to create new demands for your products—obviously difficult if not impossible to carry beyond the planning stage under wartime restrictions. The second is to find other products you can make for which a demand will continue to exist. Only the research and planning for a program of this sort can be undertaken in wartime. The third is to develop a program for orderly deflation of your activity to its anticipated minimum, providing each employee slated for dismissal with an opportunity to earn a living elsewhere. You may call this paternalism or any other name but, no matter what you call it, it is better to do it yourself than to have some politicians do it for you.

SUCH A PROGRAM has been inaugurated by far-sighted LaMotte T. Cohu, board chairman and general manager of Northrop Aircraft, Inc. On page 108 we are privileged to present Mr. Cohu's story of why the system was set up and how it works.

Those of us who know the author will not be surprised at his advanced thinking in this direction. He has always thought deeply and soundly about his responsibilities to his workers and to the community they have built around his plant. But he has not stopped there. He has implemented his thought by acts. That is why the record of labor relations at Northrop is one of the brightest spots in the aviation industry.

This article is not for aviation manufacturers alone. It should be read and studied by everyone engaged in wartime industry. You may not agree with it. You may find a dozen reasons why it might not work in your particular plant. But don't stop there. In the interests of the preservation of the enterprise system, read it with an open mind and try with sincerity to apply its principle to your own problems. It may mean the future difference between running your own plant or being told how to run it by someone who doesn't know how.

Leslie E. Neville

EDITOR

NORTHROP'S PLAN
For Postwar Employee Re-Location

By LaMOTTE T. COHU
Chairman of Board & General Manager, Northrop Aircraft, Inc.

Producers of the P-61 "Black Widow" fighter present a courageous, practical program to assure aircraftsmen full-time work right through the peace transition—on planes as long as they're needed, and on other good jobs thereafter, in direct "start-Monday" style.

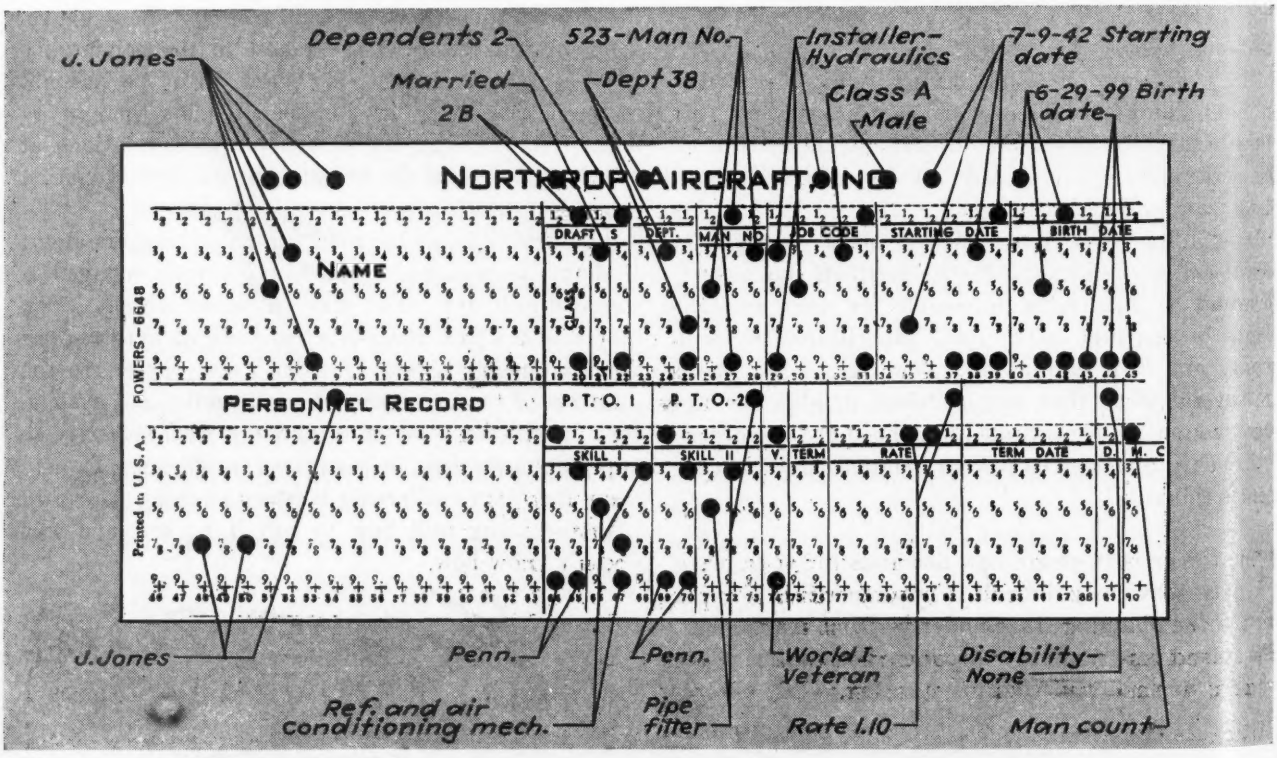
RE-LOCATION OF EMPLOYEES whose services cannot be retained for peacetime operations presents the gravest problem now confronting aircraft manufacturers. It is a problem which will grow even more grave when Germany surrenders and war production begins to be tapered off.

Unless manufacturers set up machinery to help these employees find work, the job will be done by others, and probably in ways inconsistent with the principles that have made America great.

Northrop Aircraft believes so firmly in this view that it has already inaugurated a program, unique in the annals of American business, to find a solution to the problem. In effect, the Northrop Plan is much like the company's hiring program in reverse. Instead of combing the nation for personnel, the company's industrial relations department will be combing it for jobs in peacetime industry to which employees can transfer when their skills will no longer be needed to produce the Northrop P-61 *Black Widow* night fighter, one of the Army Air Force's newest combat-class aircraft.

The Northrop company, like all others in the aircraft industry, fully expects its plane production to be curtailed as the war draws near an end. Postwar plans anticipate a production volume approximately ten percent as large as the wartime peak. But, while production will undoubtedly be curtailed before the war ends, it is expected that the armed forces will demand a high rate of production right up to the time of the armistice. To meet schedules in conformance with these demands then, it will be necessary to prevent any general labor exodus from the aircraft industry when peace appears to be in sight.

If, before the war is won, any appreciable number of workers do quit their aircraft jobs to find peacetime employment, the ensuing production slump might easily prolong the war, needlessly cost the lives of thousands of American fighting men, and bring about widespread disruption of our economic system, all at a time when victory will be in the balance. Disastrous as such conditions could be, employees could not be blamed entirely for seeking to protect their futures by "jumping while the jumping is good" if we, as employers, fail to take the lead and do all within our power to bridge the gap between their present jobs and the future.



Part of Northrop employee re-location plan includes survey of skills among employees, tabulated on cards such as this. Information includes second, as well as first, skill, present employment data, worker's former home, and other pertinent data. When time comes, Northrop will provide office space and help for personnel directors seeking workers.

LaMotte T. Cohu,
Chairman of the board and general manager of Northrop Aircraft.

● **The volume** of postwar planning has grown at an amazing pace during the last few months. But to the average employee—the man or woman on the production line—much of this planning is "just so much talk." It is just talk because that average employee can't see exactly where he, as an individual, fits into the picture. And to him, his individual future is the No. 1 problem.

To help employees solve that problem, LaMotte T. Cohu, chairman and general manager of Northrop Aircraft, has not only had a desire to aid but also the courage to *do* something about it. In developing the "Northrop Plan," Mr. Cohu has set up a unique, but nonetheless realistic, program by which the company will locate jobs for those employees it cannot hope to keep on the payrolls with the volume of business which can reasonably be expected after the war.

It is his belief that if all war industries set up plans which will in some similar manner serve their employees, the nation as a whole will in turn be served, thus freeing an already over-taxed government from one serious problem—and freeing it at a time when government will have its hands full of other critical matters.

So exacting and all-encompassing have been the demands for warplanes, few aircraft companies will have even the designs for postwar planes ready to go into immediate production for peacetime markets. Without designs, without distributors, dealers, or customers, and without reserves that might have been accumulated as "seed money" with which to launch peacetime production, it will be impossible for Northrop and others in the industry to continue employing many thousands of their present personnel.

It would, of course, be easy to cut back our organizations to a size commensurate with the volume of business we will be able to secure after the war. But that does not answer the question of the individual worker who must find a place in productive work if American freedom is to survive. It seems to us that all industries—not alone the aircraft—should consider themselves obligated to seek jobs for those who cannot be employed, and just as energetically as the employees themselves were sought in the first place.

We in the aircraft industry scoured the nation for workers, convinced them it was their patriotic duty to help win the war by building warplanes; we now rely upon them to continue their work as long as our fighting men

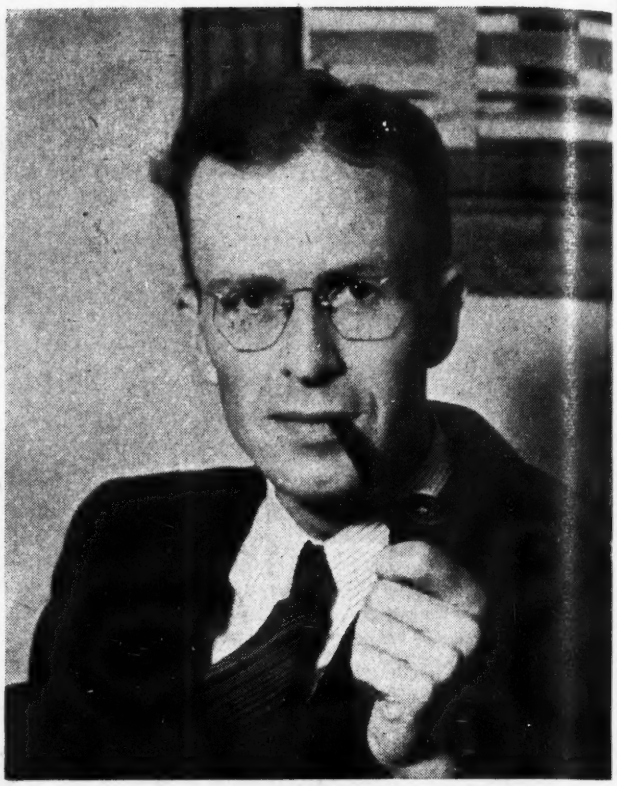
(*Turn to page* 356)

In an hour's time, modern automatic classifying machines can collate given specialized skills from a group of 10,000 mixed cards. Northrop officials believe such speed is essential to keep aircraft workers on plane production right to termination day, thus making transition from wartime to peacetime jobs swift and painless, both for employees and nation as a whole.

• **Youthful** Earle M. Scott, president of Scott Aviation Corp., started his present business in 1932 in a basement machine shop in his home, where he designed and produced the first standard attachable tail skid shoe for light aircraft. This was followed in '35 with his own tail wheel assembly, produced on a part time basis until 1940, when increasing business made larger quarters necessary. First war work, a small contract for British compass cases, was received in '41. Next, the company fought for six months to get a large and tough contract for Mark X oxygen regulators, a job experts said it couldn't do. But the contract was received and the job completed. This success brought more orders—and more than ten times the number of employees.

Scott Aviation received its Army-Navy "E" back in Nov. 1942, and the flag, with a star for continued "outstanding production achievements," is still flying. In addition to making an outstanding record in design and production of vital high-altitude oygen equipment, the company is designing and manufacturing tail wheel assemblies for CG-4A gliders and light aircraft, plus unconventional light aircraft landing gear and accessories, including hydraulic brake pressure units.

Earle Scott believes that companies such as his are entitled to a place in America's postwar business, if for no other reason than to help provide employment for loyal workers now on the payroll. But this company—and many like it—would be hard pressed to survive under present rules. Hence Scott determinedly set himself to solve the problem, and his plan is one which could well provide the pattern for action by thousands of organizations in the same position.



Earle M. Scott, president of the progressive Scott Aviation Corp.

SCOTT'S PLAN For Reconverting Small War Plants

By EARLE M. SCOTT
President, Scott Aviation Corp.

A daring, yet workable program by which thousands of smaller war contractors can survive the troubles of transition from termination to peacetime production without resorting to—or having their employees resort to—charity.

IN ALL THE DISCUSSIONS of postwar reconversion of American industry to peacetime production, almost nothing has yet been said about the thousands of smaller plants now producing for the aircraft industry. Even less has been done about attempting to establish an orderly reconversion program.

In its efforts—laudable as they are—to forestall a crop of war profiteers, the government has actually sown a crop of war orphans, especially among aircraft-field companies which have been forced to expand far beyond financially safe limits.

These orphans are not, however, looking for charity, either for themselves or their employees; they do not want or expect the government to pay their employees a dole. But they do want, and want very much, to be permitted to retain enough earned profits to enable them to set up reserves which can be used to get back into peacetime production.

In setting up our postwar plans, we at Scott Aviation Corp. found the reconversion problem to be, in reality, twins. Our solution to these problems is presented here in the hope that it might form the basis of a program which can be adapted to smaller businesses throughout the country.

Since the problem is two-edged, our plan calls for two separate reserves: Termination pay reserves and post-conversion reserves.

The first may be defined as a reserve which will enable us to give separation pay to those workers who, temporarily at least, cannot be continued in our industrial employment. Obviously, a great many companies, and especially those engaged in aircraft manufacturing, cannot use the majority of their employees during the conversion period. In our own case, for example, it is anticipated that no more than 40 percent of our workers can be kept during that transition. Many companies may only be able to retain 10 to 25 percent of their personnel.

If the country is to avoid confusion, recrimination, and want during the immediate postwar period, we must have nationwide plans right now to ameliorate the probable economic conditions. It has seemed to us that some form of termination pay is the logical solution. Failing this, the only alternative is to release from 60 to 90 percent of personnel immediately on cancellation of contracts.

Facing such a condition, we cannot

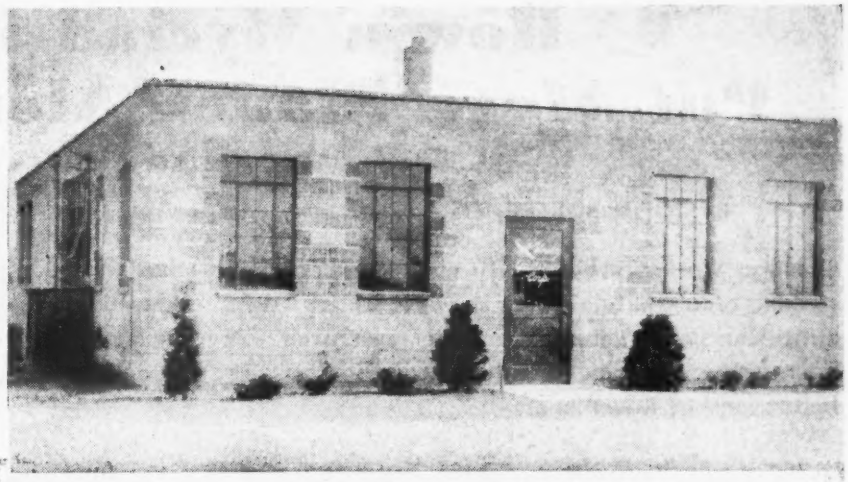
wait until cancellation day. No, things can't be forgotten till the last minute, then passed off to the faithful employees with—

"Sorry, our contracts were cancelled today, here's your pay. Maybe we can re-hire you in a couple or three months, but in the meantime, if you can't get along on your unemployment insurance and your savings, you'll have to go see Uncle Sam about relief. He wouldn't allow us to set up reserves to provide for you, so we can't do a thing but say 'goodbye and thanks a lot for your efforts'."

The thinking employee—the kind we want to keep on our payrolls—does not want charity. He or she has saved, bought war bonds, paid off old debts and, perhaps, invested in a home. Such employees are in the best financial condition they have been in for years; but, as much as they work and pray for a quick victory, they look forward with misgivings.

They are not worried about the post-war years—they have heard too many optimistic reports about the coming golden age. But they *are* worried about the conversion period. This transition may be difficult—but it need not be disastrous for the average worker if the right of a company to set up adequate tax-free reserves is recognized now.

These reserves need not involve astronomical amounts. Termination pay should be such that it is sufficient, together with the unemployment insurance, to allow the released employee to "break even" on fixed expenditures during the industry's conversion period. It should, however, be kept low enough to prevent him from adding to inflationary dangers through addition of unwarranted purchasing power. And it should be low enough so it will be financially possible for the average small company to set up the funds as reserves—untaxed, unrenegotiated, and allowed as cost.



First "street-level" plant of Scott Aviation, occupied in 1941 when expanding business forced move from basement machine shop in owner's residence.

It must further be recognized that a majority of families in war production areas have more than one member working, a fact which will allow a comparatively low and thoroughly reasonable termination pay rate per employee. Nor should termination money be paid in a lump sum on release; rather it should be in semi-monthly payments, beginning with two weeks' termination pay at the time of release.

No government subsidy is involved. None is needed or wanted. What *is* needed and wanted is the ability to retain enough of earned profits to provide employees, through termination pay, with some measure of security at a time when the most optimistic among us agree that jobs will be at a premium.

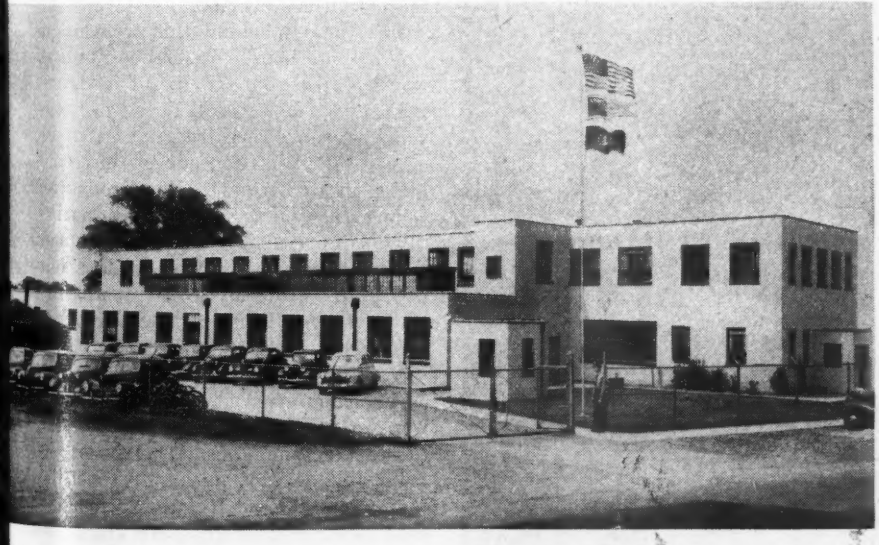
It may be argued that not all employees will actually need termination pay, especially if it is to be used as a means of meeting their fixed expenses. But what personnel director, what government official or bureau, can fairly and quickly determine every released worker's financial status? Definitely, it should be paid to all those released, and it should be in the same amount for all. That should be its only resemblance to WPA, in which all workers, regardless of their former positions or salaries, were paid equally for the same work.

Thus, in our company, reserves were set up in 1943 to make it possible (*if these reserves are allowed*) for the 60 percent of our employees who will have to be released, to at least "break even" until we can re-hire them or until they can establish themselves with other firms. This termination pay reserve will provide every released employee with $10 per week for 9 weeks. It should be pointed out that this figure has been established to supplement the New York State Unemployment Insurance Benefits of $18 per week, which start 2 weeks after unemployment begins and continue for 16 weeks. It is in accord with the policy of keeping the reserves as low as possible.

The question may well be asked: Is the duration of payments adequate? Possibly not, although in our own case we feel it is, for we believe we can convert our plants in 9 weeks. Other companies, with more difficult reconversion problems, may take from 4 to 6 months.

This, then, may well bring up another question: Should termination

(*Turn to page* 355)

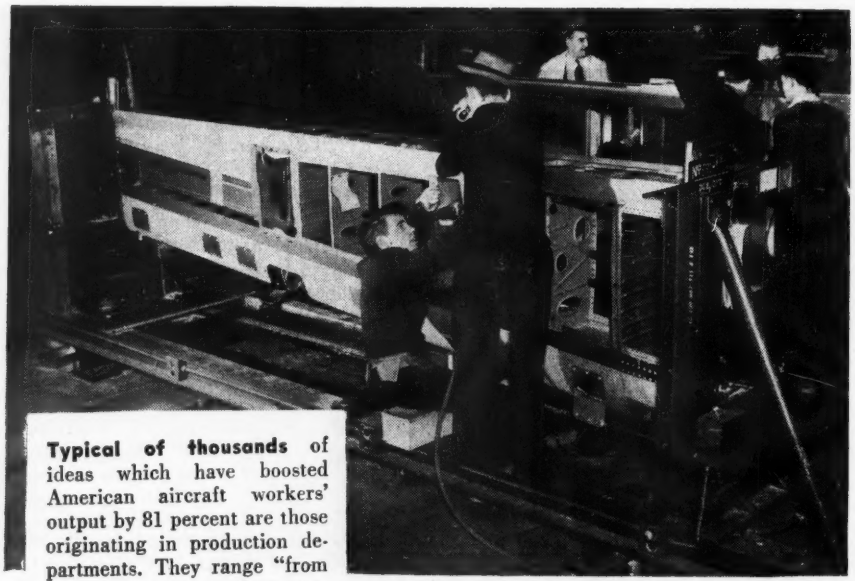


Scott's present quarters, devoted to design, development, and production of high altitude oxygen equipment and tail wheel assemblies for CG-4 gliders and light aircraft. The author's plan for establishing reserves would make it possible for these facilities to give many present workers employment in production of peacetime products.

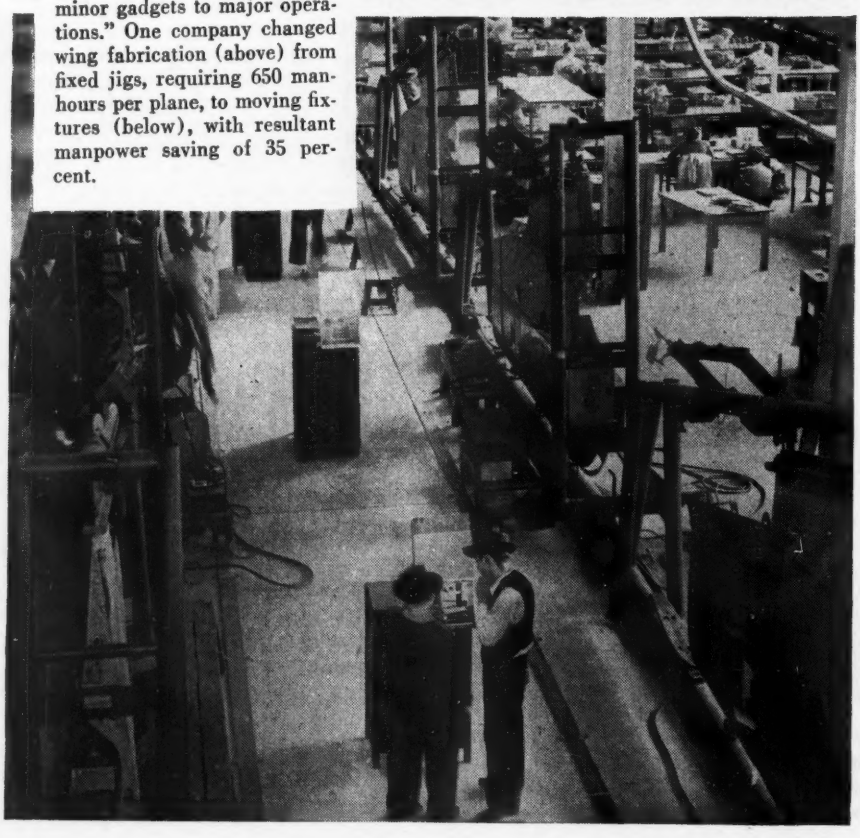
How a Myriad Ideas Put *More* Planes Aloft *Quicker*

By **JOHN FOSTER, JR.**, *Associate Editor, "Aviation"*

Average worker productivity up over 80 percent—that's the striking record disclosed by the East Coast AWPC's manpower utilization survey. Particularly demonstrated is the employee's own Victory-winning headwork, achieving greater output, faster, and at lower costs.



Typical of thousands of ideas which have boosted American aircraft workers' output by 81 percent are those originating in production departments. They range "from minor gadgets to major operations." One company changed wing fabrication (above) from fixed jigs, requiring 650 man-hours per plane, to moving fixtures (below), with resultant manpower saving of 35 percent.



AMERICA'S AIRCRAFT WORKERS today are producing 81 percent more airplane per employee than they did only two years ago.

That one bare figure means this: Poundage of airplanes has gone up more than twice as fast as has the number of employees, meaning, in turn, that the Army and Navy are getting more—and better—planes at ever-decreasing costs, both in man-hours and dollars. In fact, more than one company not only builds more planes now than ever before but actually does it with fewer employees.

This amazing production record is not a story of sweatshop operations or grueling stretches of overtime. It is, instead, part of the story of the greatest venture in industrial cooperation the nation has ever seen.

The factors behind this tremendous production boost — whereby today's worker turns out 77 lb. of airframe per month, against 42.6 lb. just two years ago—are revealed in an extensive manpower utilization survey just completed by the Aircraft War Production Council, Inc., East Coast, an organization comprised of the eight major manufacturers in that area. The output gains made by these companies' employees are being matched by others throughout the country.

The Production Council, like its earlier counterpart on the West Coast, was established by aircraft manufacturers for one specific purpose: To help win the war quicker by "pooling their experiences for the benefit of each other and, in fact, for the entire aircraft industry." The manpower utilization survey, undertaken as part of this program, examined functions in engineering, industrial relations, fac-

tory operations, tooling, and general operations.

Many of the outstanding manpower savings have been made in the engineering departments. As recently as late 1940, it must be remembered, these departments were staffed largely with men of considerable experience and with versatility which permitted them to handle many phases of complicated work. Thus, when a new design gave promise of finding a market, specifications were prepared and a group of engineers were "stuck in the corner" and told to come up with the complete plane. These men then laid out the basic design, justified structural adequacy, prepared the hundreds of necessary detail drawings, and worked closely with the skilled shopmen who thereafter fabricated and assembled the parts. With such groups, the average company could handle the design of one or two experimental planes and the problems of, say, two models in limited production.

Today, although engineering employment has passed its peak, the number of engineering employees is, in most cases, far greater than was total employment of the companies in 1940. The great majority of the new employees had no previous aircraft experience, which meant the "old line" engineers not only had to do designing but also had to educate the new employees. As a matter of fact, a large proportion of the new employees had no previous engineering experience at all, a fact especially true among women workers. One company's engineering department, for example, now employs 33⅓ percent women, compared with 7 percent 16 months ago. And, where there were no women in the drawing control section, there are now 26.

Engineering departments today often employ more people than did entire plants only short time ago. But plane production has gone up more than twice as fast as employment because of manpower utilization efficiencies which mean more and far better planes.

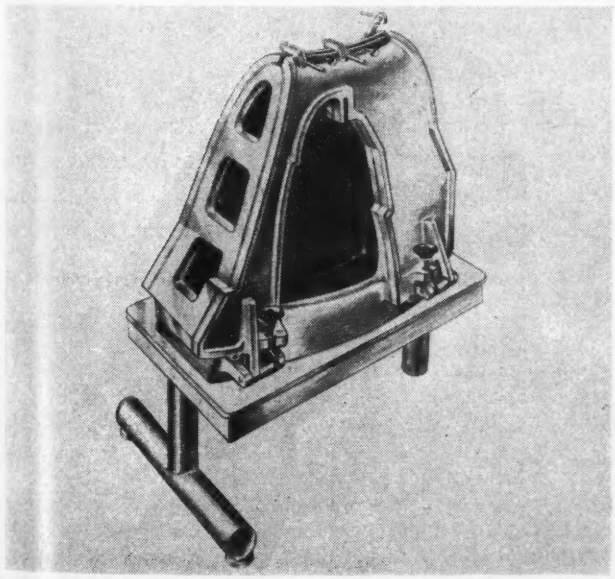
This same company reports that artists and cartoonists, as well as others whose prewar work was, for example, confined to designing ladies dresses, have, under tutelage of the "old line" engineers, been trained to do technical illustrating.

One of the toughest problems aircraft engineers face is that of quickly making design changes required by lessons learned in battle. One member company reported holding such changes to a minimum by setting up a "change analysis group" whose prime function is thorough investigation of every proposed change. Nevertheless, each plane model still goes through an average of 125 design changes, over half of which are military requests.

In another case design changes—averaging 400 a month—originally were sent through a routine requiring marking of many large blueprints, then making new prints incorporating the changes. Now, though, up to 60,000 man-hours per month of drafting time are saved by using an engineering order which contains all necessary information plus a drawing only of the affected part. The order is then attached to the original large drawing, and it officially becomes a part of it.

With the terrific expansion which has been forced on the aircraft indus-

(*Turn to page* 351)



Former dress designers, cartoonists, and commercial artists not only have found work in aircraft manufacturing but also have helped develop new techniques (such as graphic illustration) to help new production line workers learn jobs faster. Three-dimension drawings, like this one, have proved of great value to workers unable to read blueprints.

Aircraft manufacturers increase manpower utilization by arranging "off-the-job" activities that keep employees on the job. These range from personal service departments to such projects as child care centers (see photo). Influx of women workers—now accounting for about half of all employees—has brought about sharp increases in off-job activities by producers.

Hard Facts for Future Stressed in IAS Annual Papers

Design and production techniques for critical readjustment period are in primary focus as Institute of the Aeronautical Sciences meets in third wartime conclave.

ALTHOUGH POSTWAR considerations frequently cropped up to invite future speculation, hard facts rather than hazy predictions characterized the majority of papers presented at the 12th Annual Meeting of the Institute of Aeronautical Sciences, recently held in New York City.

Official ceremonies at the Honors Night Dinner were topped with election of Maj. Reuben H. Fleet as president of the Institute for 1944. Honorary fellowships were conferred on AAF Gen. H. H. Arnold and Sir Richard Fairey, director general, British Air Commission, for their "preeminence in aeronautics," and honorary membership was conferred on Rear Adm. D. C. Ramsey, chief of the Bureau of Aeronautics, Navy Dept.

Aside from the Honors Night Dinner—with more than 1,000 present—greatest attendance was at the Rotating Wing Aircraft session on the last night.

Reinhardt M. Rosenberg, A. F. Donovan, and M. Goland presented papers dealing with chronic problems of flight instability now facing helicopter designers. Walter Castles, Jr., in his paper titled *A Direct Method of Calculating the Maximum Rate of Climb, Top Speed, and the Other Useful Performance Characteristics of a Helicopter in Powered Flight*, presented both formulas and graphs which embodied effects of vertical parasite drag components and variable tip losses in determining helicopter performance.

Aircraft Production and Design

In making a general appraisal of bonding materials and their place in aircraft industry, Henry Grinsfelder and Thomas D. Perry's *Resin Adhesives for Aircraft*, pointed up the general characteristics and various uses of standard ureas, fortified ureas, and formaldehyde compounds, and there was mention of the great utility promise of melamine resins. Brief note was made of commercial importance of thermosetting resins over thermoplastic resins and in addition there was a discussion of heat curing bonds. Principles of flat, formed, and monocoque plywood construction were further described and relative advantages presented.

Leonard Weiss, in his paper, *The Use of Cast Plastics for Aircraft Tooling*, based his argument for cast plastics on the fact that plastic tooling is useful in experimental work and plywood forming. Offering savings in money, skilled labor, and materials, this scheme, declared Weiss, should be of greatest value in the postwar conversion period. Limitations, however, would probably prevent it from replacing more than 10 percent of traditional tools.

According to *The Trend of Wood Use in Aircraft* by R. W. Hess, wood application in industry is undergoing

(*Turn to page* 359)

SKETCHED AT THE SESSIONS BY E. P. KORN

Arthur M. Young

John C. Leslie

George W. deBell

Fletcher N. Pratt

Col. H. F. Gregory

Igor Sikorsky

George Brady

Ralph H. Upson

Here's the "T" Loan

By RAYMOND L. HOADLEY
Financial Editor, "Aviation"

Baruch-sponsored successor to the V and VT measures aims to assist war contractors through those difficult days lying between "the ending and the new beginning"—the nether period from termination through reconversion.

BIT BY BIT the blueprints are taking form, revealing just how Washington officials plan to keep the aircraft industry on its feet during the critical transitional stage back to peacetime production.

Such knotty problems as postwar reserves are still in the "think" stage, but a comprehensive termination-financing problem is being readied to bridge the reconversion gap for aircraft and other war contractors.

At the outset it should be spread on the minutes that Bernard Baruch and his postwar adjustment group recognize that even under the most favorable conditions termination will be a 4- to 6-mo. job. And they also know that the aircraft maker must have his money available within 30 days after cancellation.

So the first thing that Baruch and his advisors have done from the financing angle is to work up a brand new type of termination loan—the "T" loan—to displace the out-moded, and frequently unsatisfactory, Regulation V and VT types of war production loans.

Here is the way the old V loan mechanism worked: An aircraft contractor with, say, a $1,000,000 prewar business (remember those days?) had a $100,000 credit at his bank. Then along came that $10,000,000 order for warplanes—and a $1,000,000 bank credit was immediately needed to carry the extra volume. Thereupon, under the V-loan scheme, the bank loaned the contractor the $1,000,000 and the government guaranteed 90 percent of it, or $900,000.

(*Turn to page* 348)

Called For

in the government's plan to finance prime contractors and first-level subcontractors after contract termination are—

1. T loans to supplant the existing V and VT guaranteed loans.
2. Mandatory 100-percent payments on disputed items.
3. Mandatory partial payments to prime contractors and first-level subcontractors.
4. Designation of settlement-period interest as an allowable cost of termination.
5. Decentralization of procedure on loans.
6. Simplification of existing new financial procedures.
7. Establishment of financial aids for the subcontractor.

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Engine alone weighs 81 lbs. 15 oz. *The complete Andover Auxiliary Power Plant consists of a two-cylinder air-cooled 10 H. P. engine driving a 28.5-volt generator supplying a continuous power output of 5 K. W. with a peak load of 7½ K. W. Its complete weight with generator and adapter is only 116 lbs.*

On their way to make another bombing mission . . . they're *sure* of continuous electric power with an Auxiliary Power Unit aboard.

Yes, they're *sure* their main engines and vital battle accessories have been carefully checked with the help of the Andover Auxiliary Unit . . . they're *sure* of constant electric power for the operation of gun turrets, bomb-bay doors, instruments, radio, interplane communication, etc. . . . they're *sure* of a never-failing source of electric power in any emergency.

That's what the Andover Auxiliary Power Unit is doing today. And in industries tomorrow they'll help these boys again by furnishing auxiliary power—electric energy or horsepower—where portability, lightness and compactness are desired.

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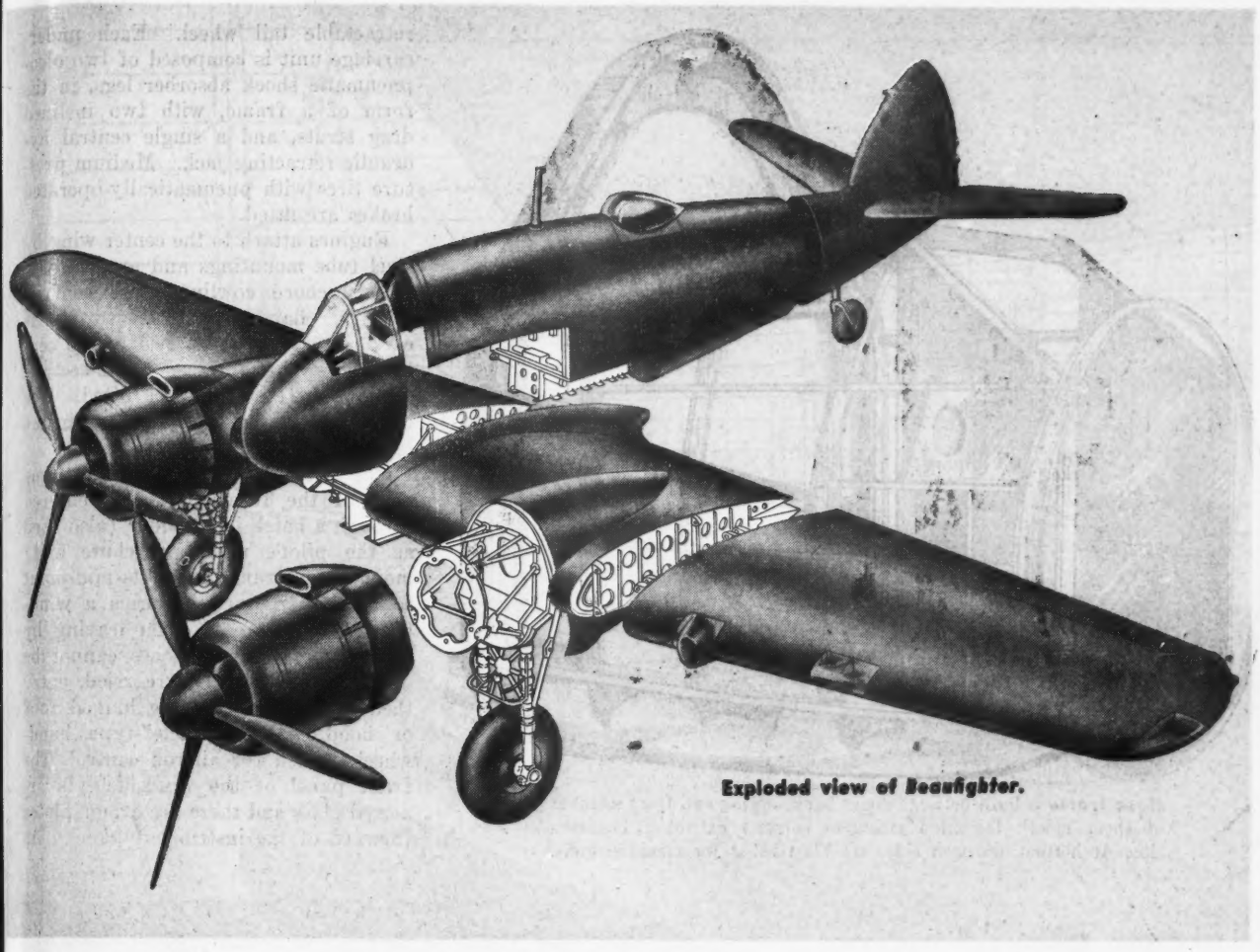


Exploded view of Beaufighter.

Design Analysis No. 5

Bristol Beaufighter

Comprehensive engineering study—complete with detail photos, sectional sketches, and pertinent tables—of Britain's famed night fighter, with notes included on its strategic adaption for Army cooperation and Coastal Command torpedo-bomber work.

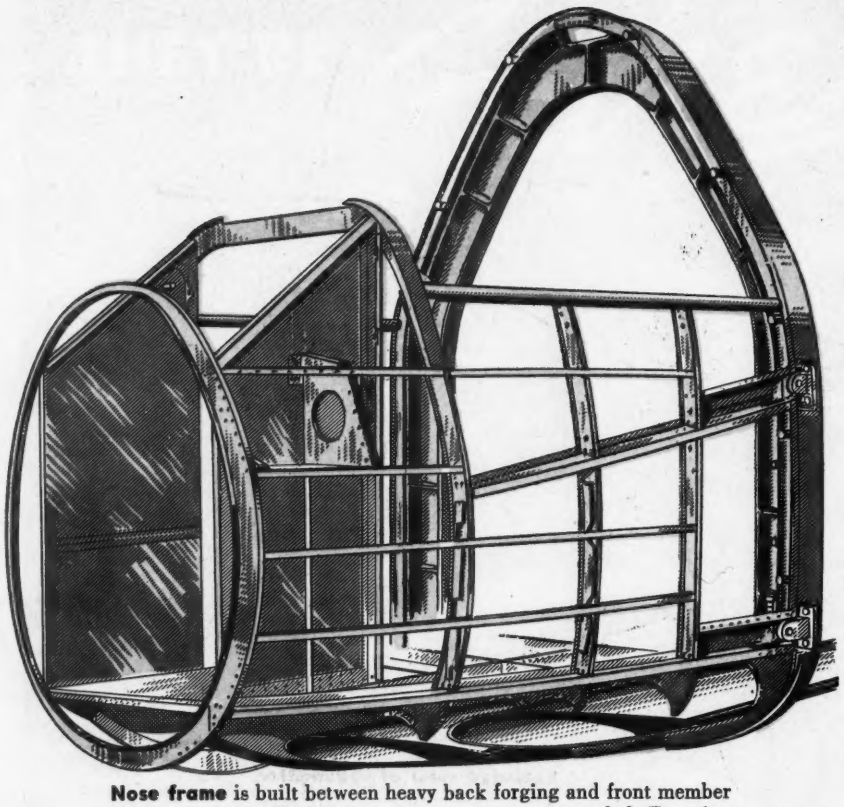
BRITAIN'S Beaufighter is an all-metal mid-wing monoplane used as a two-seat long-range fighter or fighter-bomber for day or night duties. Special equipment is installed when these aircraft are operated by the Coastal Command. A number also act as torpedo-carriers.

The main wing, of light-alloy stressed-skin two-spar construction, is made up of a center section and two outer wing panels with detachable wingtips. The center section forms the basic structure of the aircraft, for not only are the outer wing panels attached directly to it but also the front and rear fuselage sections, undercarriage units, and engine nacelles. Ailerons are light-alloy, fabric- or metal-covered structures. They are inset and are of Frise type, with both aerodynamic and mass balance. There is an adjustable tab on the left aileron and a trim tab on the right one. Hydraulically operated all-metal split flaps extend between the inner ends of the ailerons and the sides of the fuselage.

Fuselage of this craft is a semi-monocoque structure with closely spaced Alclad formers of lipped channel or Z-section, extruded angle-section stringers, and an Alclad skin. There is a reinforced crash frame immediately behind the pilot's cockpit and others at the joint midway between the rear cockpit and the tail. Otherwise the formers are mainly of light construction. Keel members along the bottom of the fuselage carry the concentrated loads from the 20-mm. guns.

Fixed surfaces of the tail unit are conventional stressed-skin structures. The rudder and elevators have light-alloy framework with fabric covering. A trim tab is fitted to the rudder, while there are both trim and balance tabs on the elevators.

The landing gear consists of two retractable undercarriage units and a

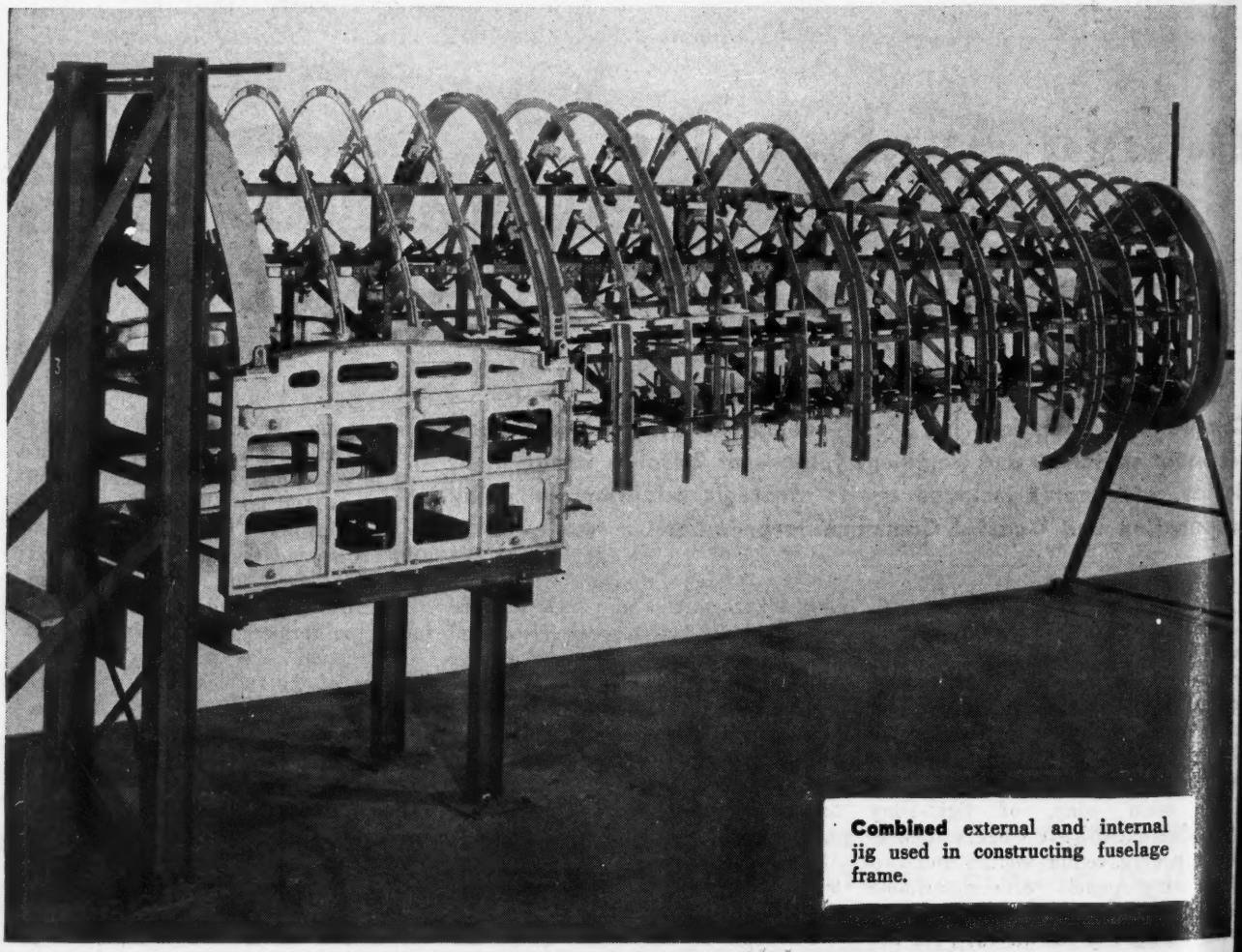


Nose frame is built between heavy back forging and front member of sheet metal. U-section stringers connect extruded T-section ribs. At bottom, on each side, are blast tubes for machine guns.

retractable tail wheel. Each undercarriage unit is composed of two oleo-pneumatic shock absorber legs, in the form of a frame, with two inclined drag struts, and a single central hydraulic retracting jack. Medium pressure tires with pneumatically-operated brakes are fitted.

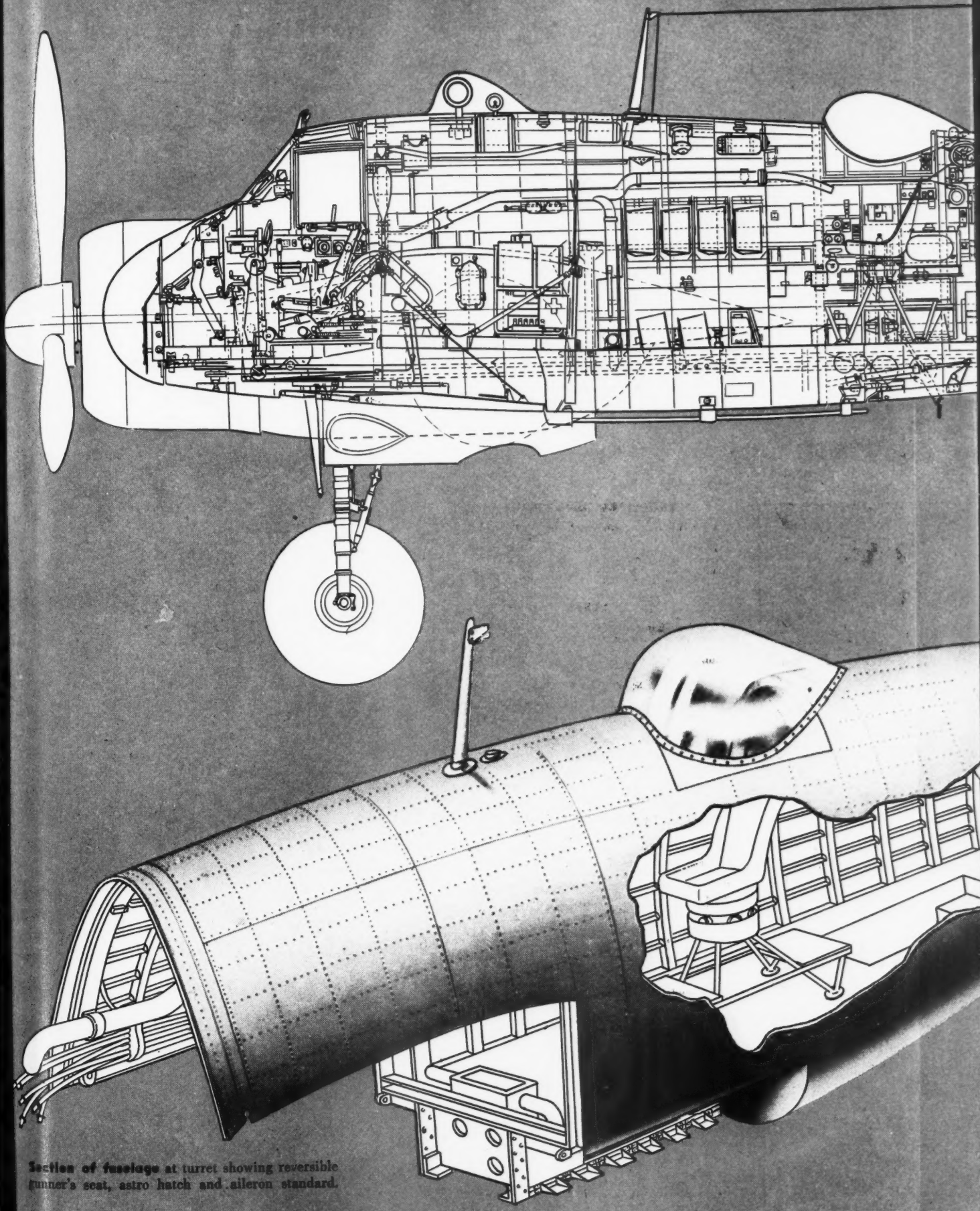
Engines attach to the center wing by steel tube mountings and are enclosed in long-chord cowlings with controllable air flaps. The fuel supply is carried in four tanks, two in the center wing and one in each outer section. Long-range tanks may be fitted. The oil coolers are mounted in ducts in the leading edges of the outer wings.

The pilot's cockpit is in the extreme nose of the fuselage and is entered through a hatch in the floor (also used as the pilot's main parachute exit) mounted on trunnions at its mid-point so that when open it forms a windbreak for the pilot when leaving by parachute. Under hatches cannot be used when a torpedo is carried, entry then being made via the hinged roof or hood. A "spectacle"-type handwheel is used for aileron control. The front panel of the windshield is armored glass and there are armor plates forward of the instrument panel. As

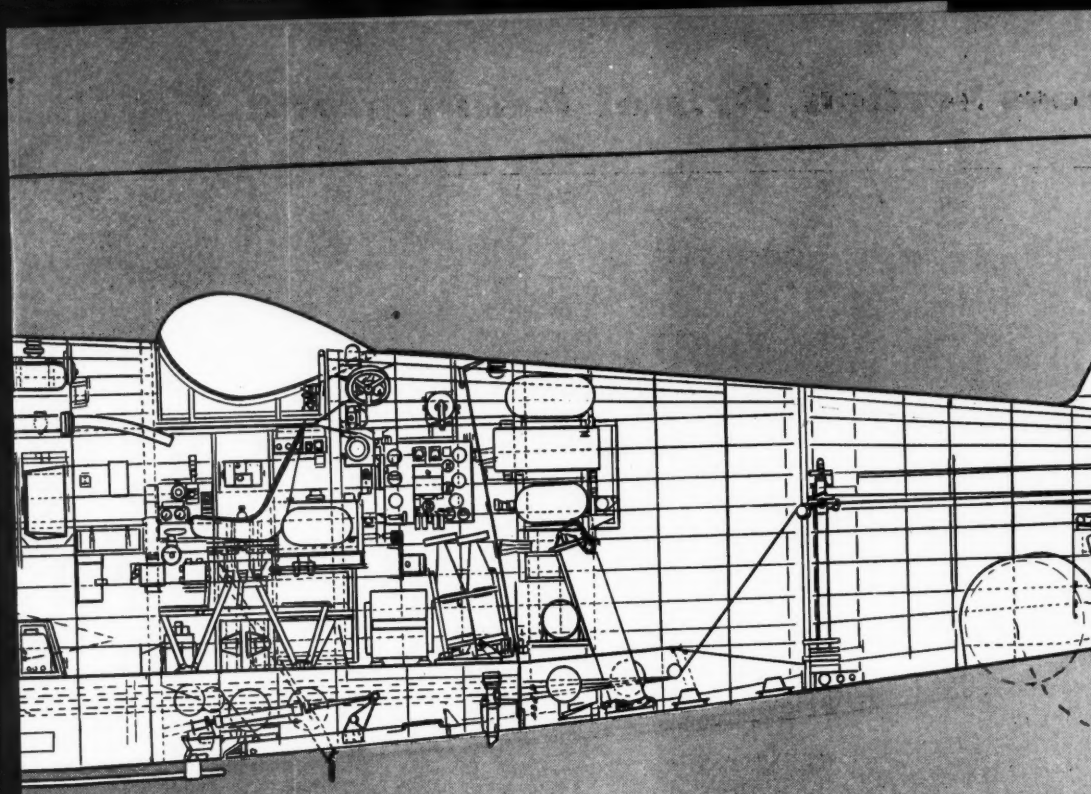


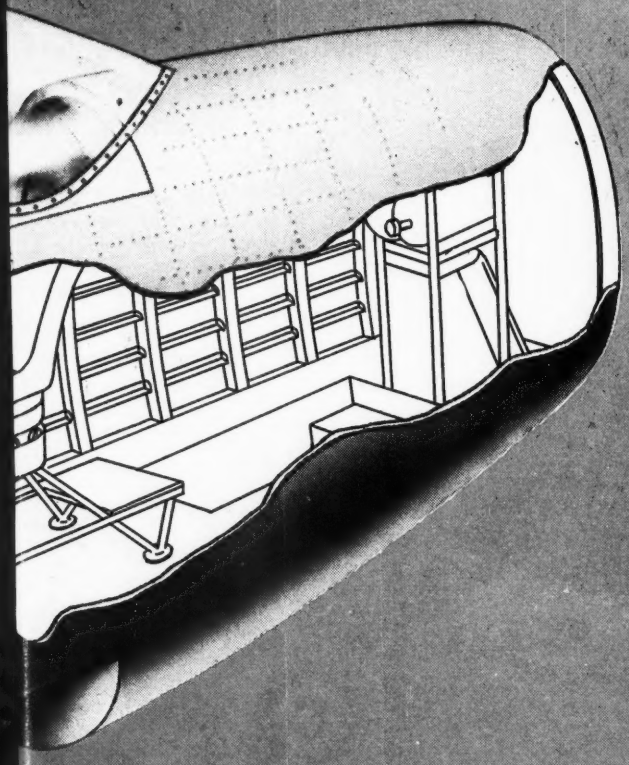
Combined external and internal jig used in constructing fuselage frame.

Cross Section, Bristol *Beaufighter*

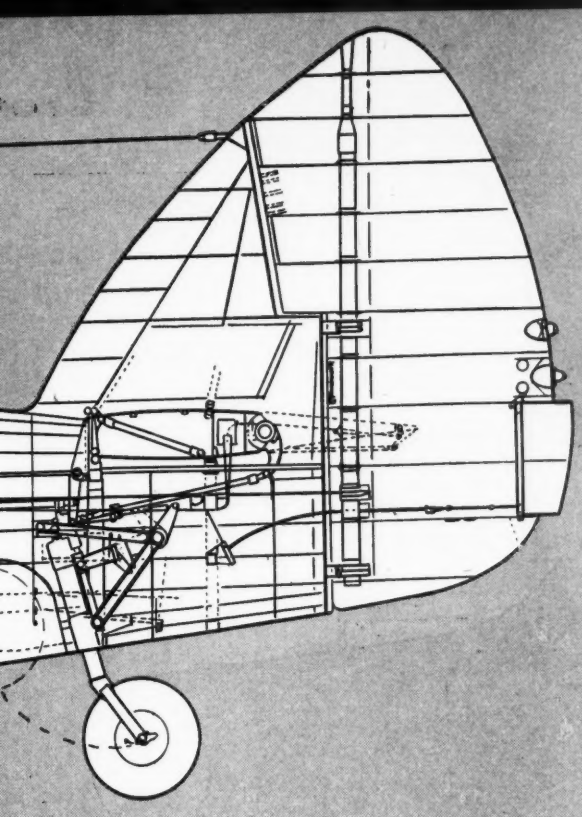


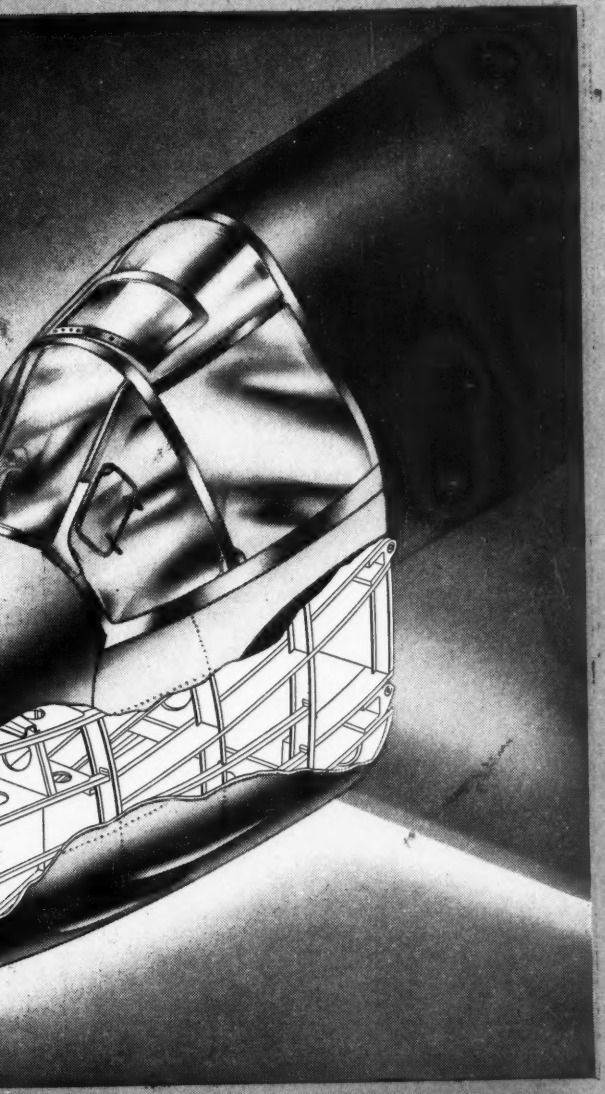
Section of fuselage at turret showing reversible gunner's seat, astro hatch and aileron standard.



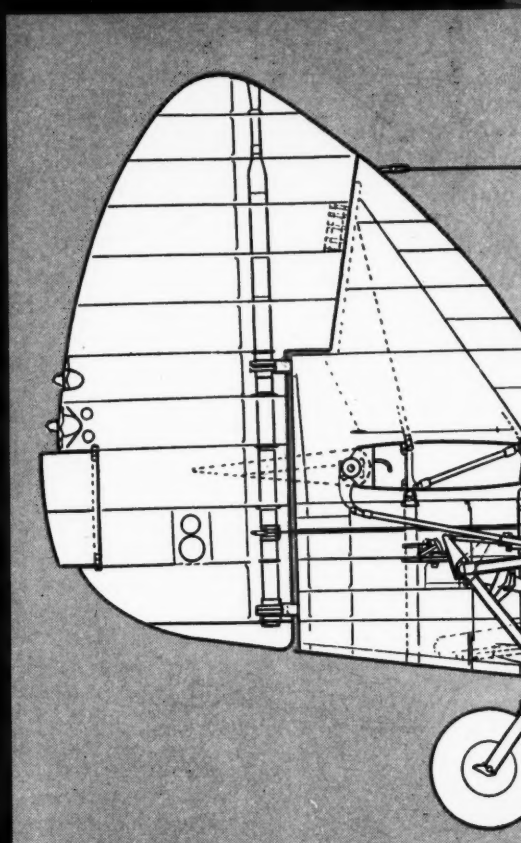


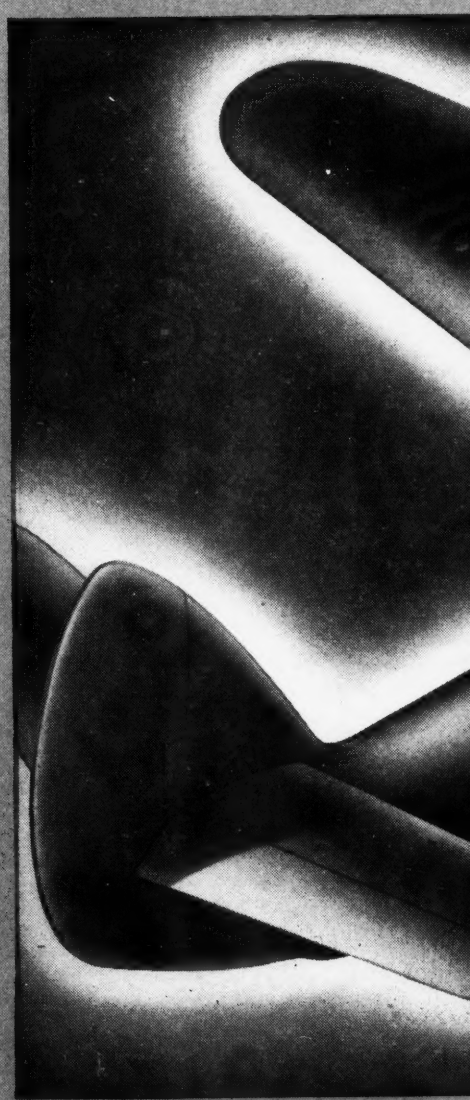
Front fuselage showing armor protection
dows for bad weather. Emergency hatch in
for emergency exit.





ction and bullet proof windshield fitted with direct vision win-
ch in roof is for pilot exit in crash landings. Seat is collapsible





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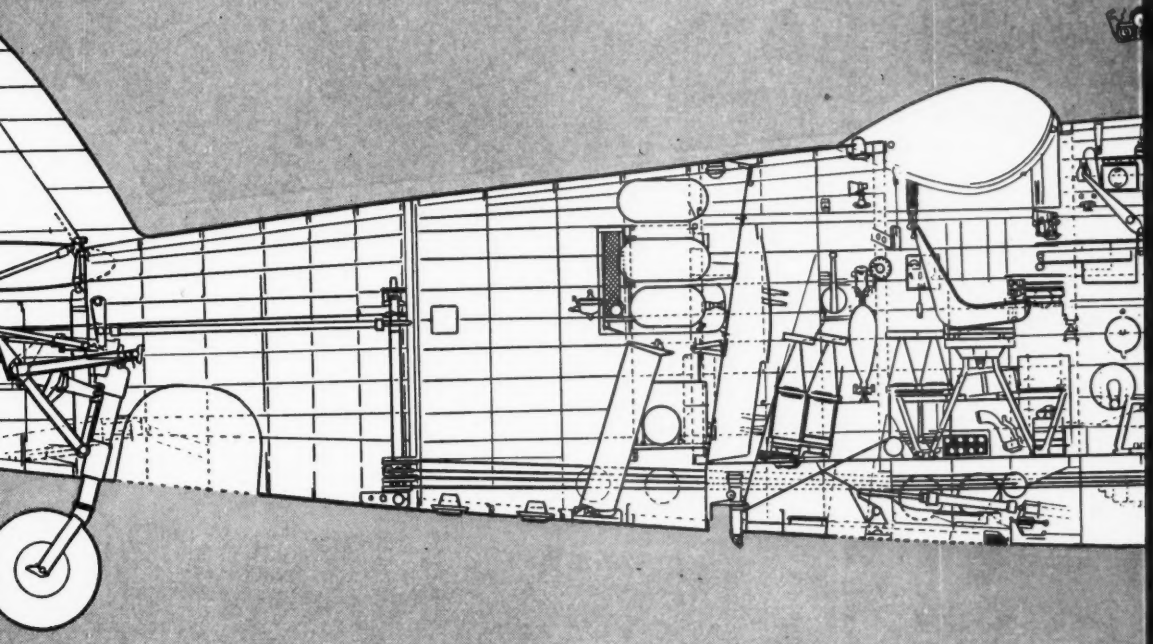
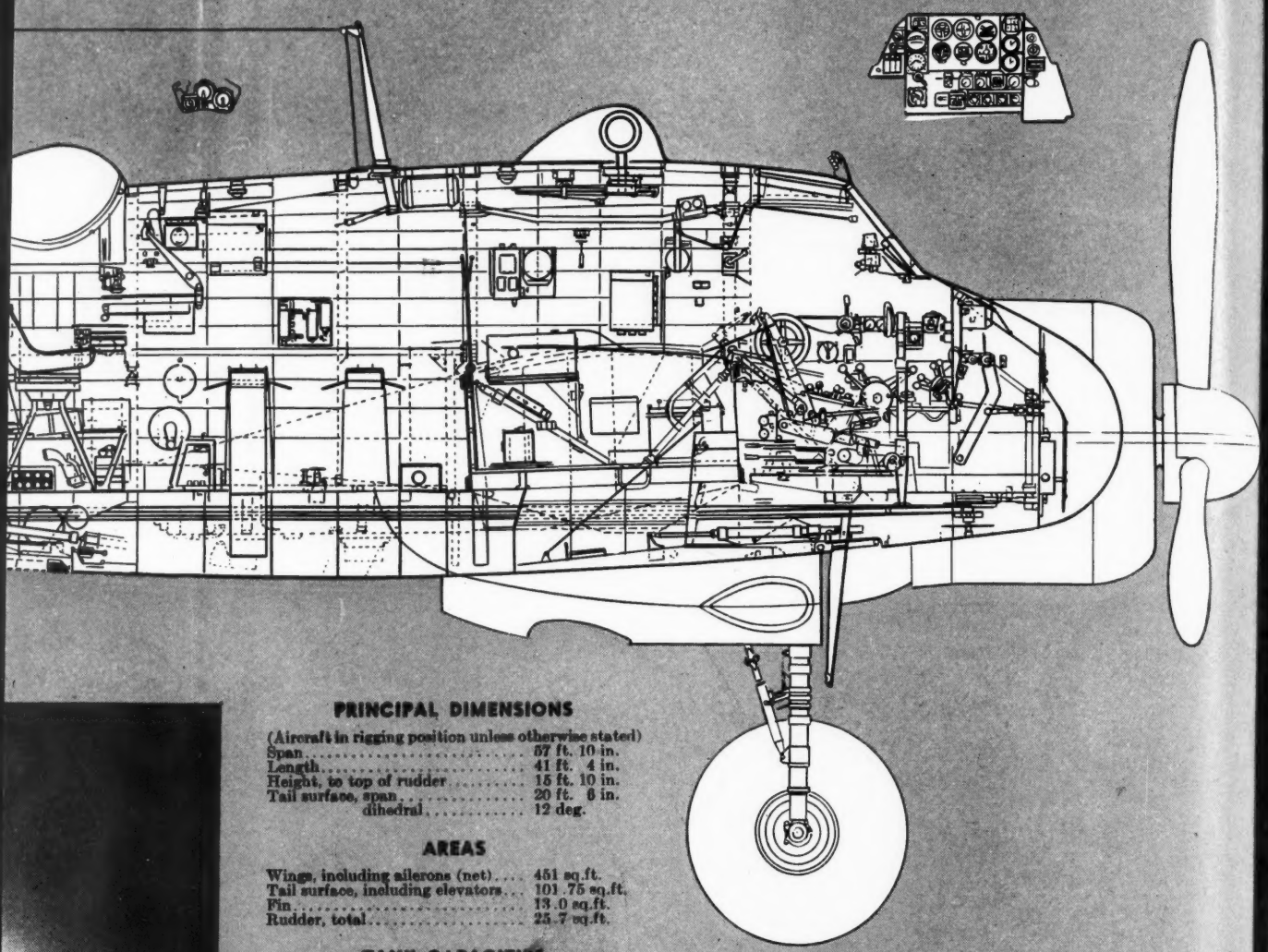
Emergency exits and
landings, pilot has knocke
square hatch and is open

Cross Section, Bristol *Beaufighter*



and equipment. Hydraulically operated exits in floor give still air for parachute jumps. For crash knockout panel at right and observer has hinged dome. Dinghy for sea landings is in left wing beneath is operated by wire release from various points. Automatic fire extinguishers are fitted throughout.



PRINCIPAL DIMENSIONS

(Aircraft in rigging position unless otherwise stated)

Span	57 ft. 10 in.
Length	41 ft. 4 in.
Height, to top of rudder	15 ft. 10 in.
Tail surface, span	20 ft. 6 in.
dihedral	12 deg.

AREAS

Wings, including ailerons (net)	451 sq.ft.
Tail surface, including elevators	101.75 sq.ft.
Fin	13.0 sq.ft.
Rudder, total	25.7 sq.ft.

TANK CAPACITIES

Fuel, center wing tanks (two)	188 gal. each
Outer wing tanks (two)	87 gal. each
Total fuel	550 gal.
Oil, two tanks	18 gal. each
air space	2 gal. each
Total oil	36 gal.

TABLE OF WEIGHTS

Removal Items of Military Load	Normal range Weight lb.	Long range Weight lb.	Desert load Weight lb.
Pilot and parachute	200	200	200
Observer and parachute	200	200	200
4 20-mm. guns and accessories	452	452	452
4 drums, ammunition for 20-mm. guns	240	240	240
12 drums, reserve ammunition	720	720	720
6 .303 Browning guns in wings	149	.....	149
6,000 rounds of .303 ammunition	397.5	....	397.5
Signal pistol and cartridges	8	8	8
Camera G.42 B	10	10	10
Oxygen, 3 cylinders	43.5	43.5	43.5
Desert equipment	.....	.....	156
Dinghy	24	24	24
First aid outfit	3	3	3
Radio	331.5	171.5	124.5
Sundries	7.5	8	7.5
Total	2,876	2,080	2,735
Fuel, 550 gal. at 7.2 lb./gal.	3,958	3,958	3,958
Fuel, 129 gal. at 7.2 lb./gal.	.....	930	.....
Oil, 32 gal. at 9.0 lb./gal.	288	288	288
Gross weight	14,069	14,214	14,069
Total	21,101	21,470	21,050

rearward protection for the pilot, a pair of armor-plate bulkhead doors are attached to the rear spar where the latter crosses the fuselage. The pilot is provided with all the usual instruments required for long-range fighter and fighter-bomber duties.

Entire armament of the plane is under control of the pilot. Carried are four 20-mm. guns, mounted in the bottom of the fuselage, also four .303 machine guns in the right wing and two .303 machine guns in the left wing. However, the .303's may be replaced by extra fuel tanks. Bombs may be carried under the wings.

The rear cockpit, which is aft of the trailing edge of the wing, is occupied on Fighter Command aircraft by a radio operator, who also acts as lookout and as 20-mm. gun loader for the earlier-type drum-fed guns. On Coastal Command aircraft, the occupant is a radio operator-avigator, but with the same additional duties. In fighter aircraft a seat-type parachute is used, but on the coastal type a lap pack gives the avigator greater freedom. Coastal aircraft are also equipped with D.F. radio, general avigational equipment, and a chart table forward of the rear seat. The rear cockpit is entered by a hatch in the floor similar to the pilot's. There is free movement from the rear cockpit to the pilot's seat.

On early aircraft, the 20-mm. guns had drum feed, with racks of spare drums, but on the later types a belt feed is fitted. All usual radio and operational equipment is installed and a crate of desert equipment can also be carried.

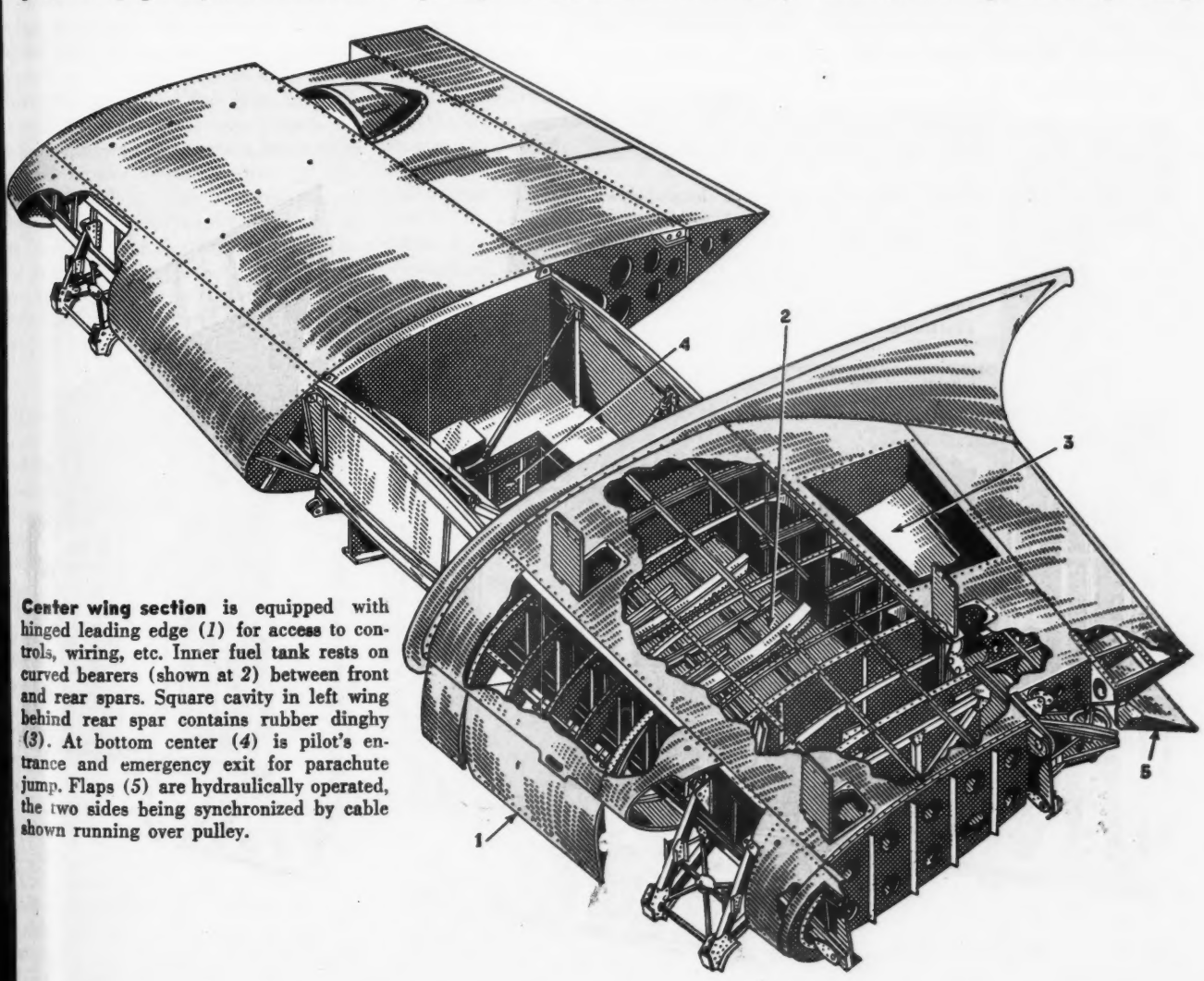
The dinghy, in the rear left center wing, is manually released by pulling any one of three handles: 1. Above front spar on left side, 2. below observer's emergency door release handle on left side, 3. externally, atop fuselage forward of fin. The dinghy can be automatically released by an immersion switch below the cockpit floor. Marine distress signals are stowed with dinghy.

Fuselage

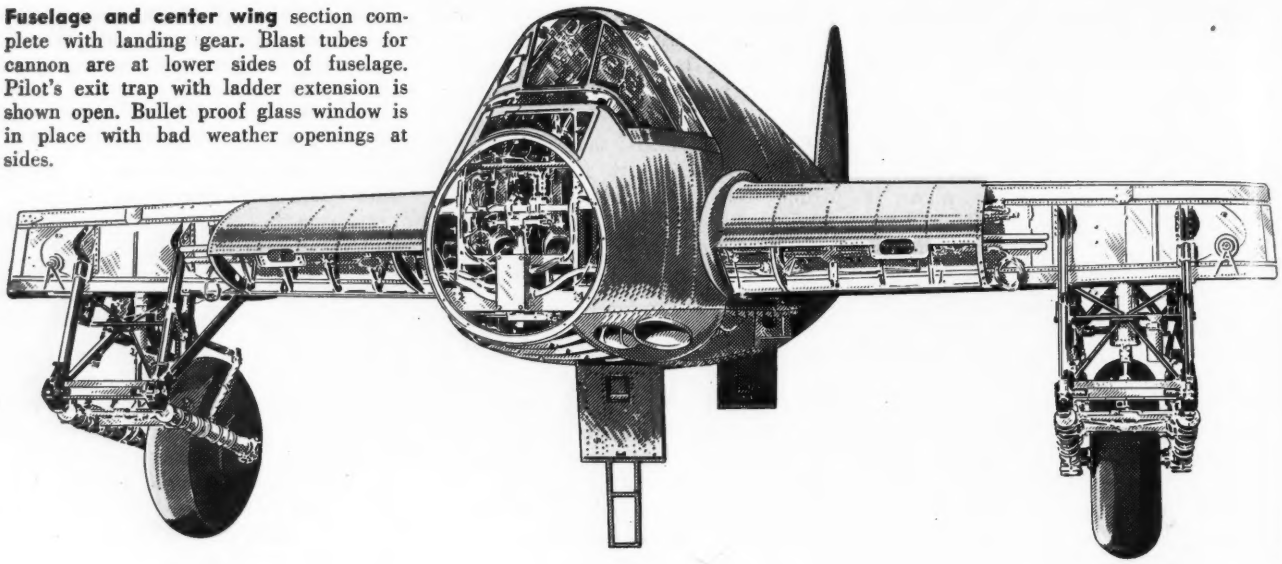
The fuselage, in three sections of all-metal monocoque construction, consists of Alclad formers, mainly of lipped Z-section, extruded light alloy beaded angle stringers, and Alclad skin plating. Countersunk aluminum-alloy rivets secure the formers and stringers to the skin but are not attached to each other, the formers being notched to clear the stringers.

Front fuselage: Here the main structure is of Alclad Z-section and channel-section formers and skin plating, with extruded beaded-angle, fore-and-aft stringers. Substantial keel members extend forward and two longerons are fitted left and right. The top longeron and a longitudinal member on each side carry a shelf for the engine auxiliary controls and other equipment. The bottom longeron is near floor level. A tubular structure, mainly of mild steel, supports the pilot's seat. Below the windshield and reaching forward are non-magnetic bullet-proof armor plates, and forward of these the nose piece is detachable. Blast tubes for the four guns are under the floor outside the keel members. Front hatch is between main wing spars.

The roof and part of the sides of the pilot's cockpit are covered with transparent sheeting, and a bullet-proof windshield is fitted at the front. The framework of light-alloy tubular members and magnesium-alloy castings



Center wing section is equipped with hinged leading edge (*1*) for access to controls, wiring, etc. Inner fuel tank rests on curved bearers (shown at 2) between front and rear spars. Square cavity in left wing behind rear spar contains rubber dinghy (*3*). At bottom center (*4*) is pilot's entrance and emergency exit for parachute jump. Flaps (*5*) are hydraulically operated, the two sides being synchronized by cable shown running over pulley.

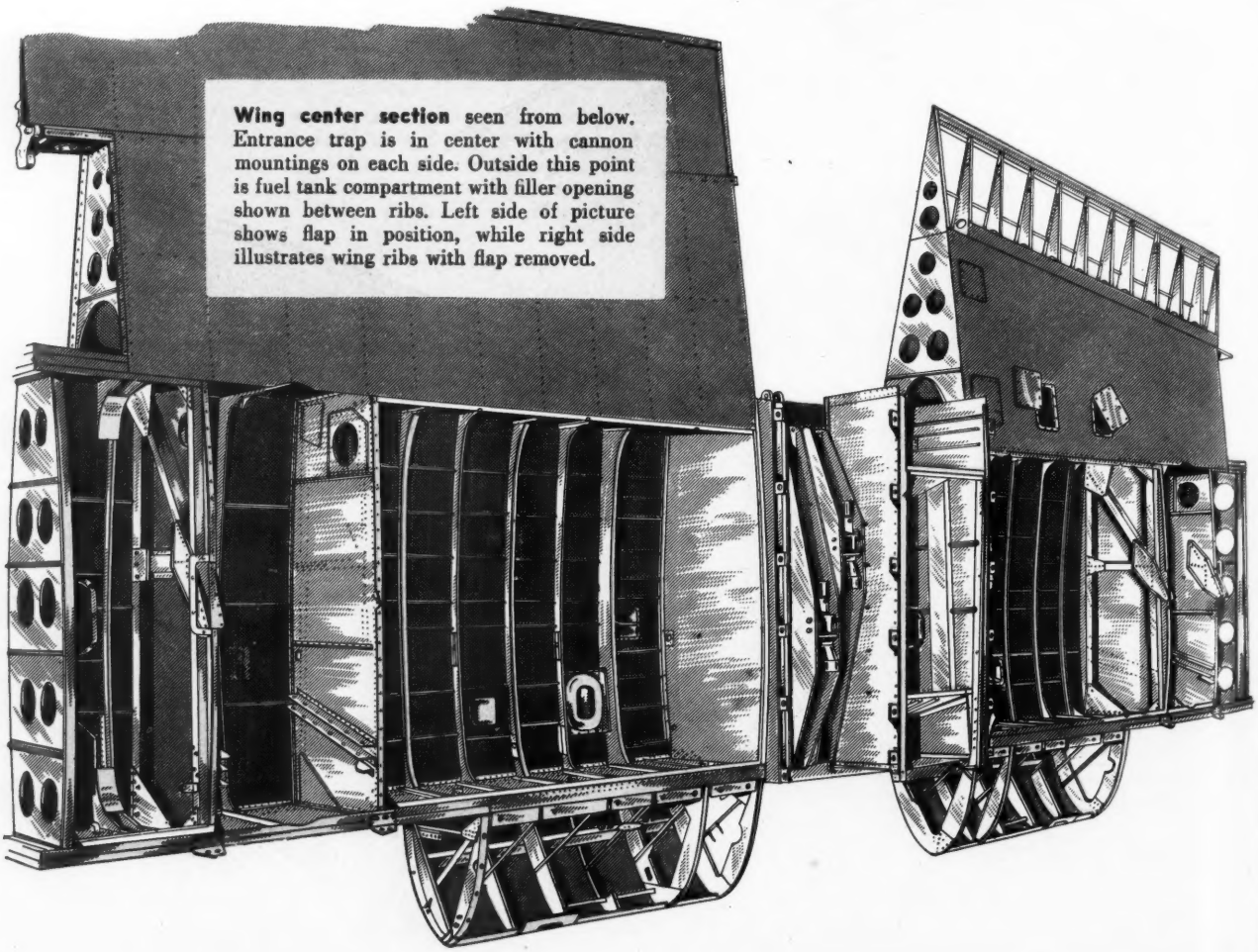


Fuselage and center wing section complete with landing gear. Blast tubes for cannon are at lower sides of fuselage. Pilot's exit trap with ladder extension is shown open. Bullet proof glass window is in place with bad weather openings at sides.

is bolted to the main structure. Transparent sheeting, mounted on rubber, is secured to the framework by light-alloy cover strips. Additional emergency exits are a knock-out window on the right side and a hinged roof window. Two screens compose the pilot's windshield, the outer of $\frac{1}{4}$-in. Triplex and the inner one of six $\frac{1}{4}$-in. glass plates, making a bullet-proof shield. The screens are separated by a $\frac{3}{8}$ in. air gap through which warm air is passed to prevent frosting.

Rear fuselage is generally similar to the main structure of the front fuselage. The observer's hood—about midway along its length—is made of transparent sheeting supported on a tubular frame, hinged on the right side for emergency exit. Keel members extend the whole length of the rear fuselage. Armor is fitted on the front of the rear spar and extends upwards 20-in., while two doors with a central handle are above the spar.

In the rear fuselage are several double formers of lipped channel placed back to back some distance apart with a plate riveted across their flanges on the inboard side. The formers at the center wing spars have Hiduminum forked blocks riveted and bolted to the web of the channels at the bot-



Wing center section seen from below. Entrance trap is in center with cannon mountings on each side. Outside this point is fuel tank compartment with filler opening shown between ribs. Left side of picture shows flap in position, while right side illustrates wing ribs with flap removed.

tom for attachment to the box ribs on the center wing. The rear fuselage is strengthened by three longerons on each side. The top and middle longerons are of channel riveted to top and bottom angles attached to the skin; the bottom longeron is of lipped-channel, built up of a plate and two Z-sections, the top and bottom flanges of which are attached to the skin.

Rear frame comprises lipped Z-section formers, bulb-angle stringers, and Alclad skin plating. The aft end of the frame is formed by a sternpost carrying the rudder bottom hinge and extended upward to carry the top hinge. A special section stringer is near the bottom on each side. An aperture in the underside of the frame, boxed-in with aluminum-manganese alloy and plastic sheet, provides a housing for the tail wheel unit when it is retracted.

Attachment of Front and Rear Fuselage and Center Plane

Ends of the skin plating of the front and rear fuselage butt together and are secured by setscrews and Simmonds nuts to butt straps underneath. The other attachments are made at the Hiduminium blocks on the box ribs of the center wing. Two blocks, near the bottom of the front fuselage, are riveted to channels that are in turn riveted to angles on the skin and are secured by high-tensile steel bolts in steel bushings to the formed horizontal pair of blocks at the bottom of the center wing box ribs. Extruded and plate angles strengthen the curve of the fuselage over the top of the wing. The rear horizontal blocks on the box ribs are attached by bolts and steel bushings to a block riveted to each middle longeron of the rear fuselage.

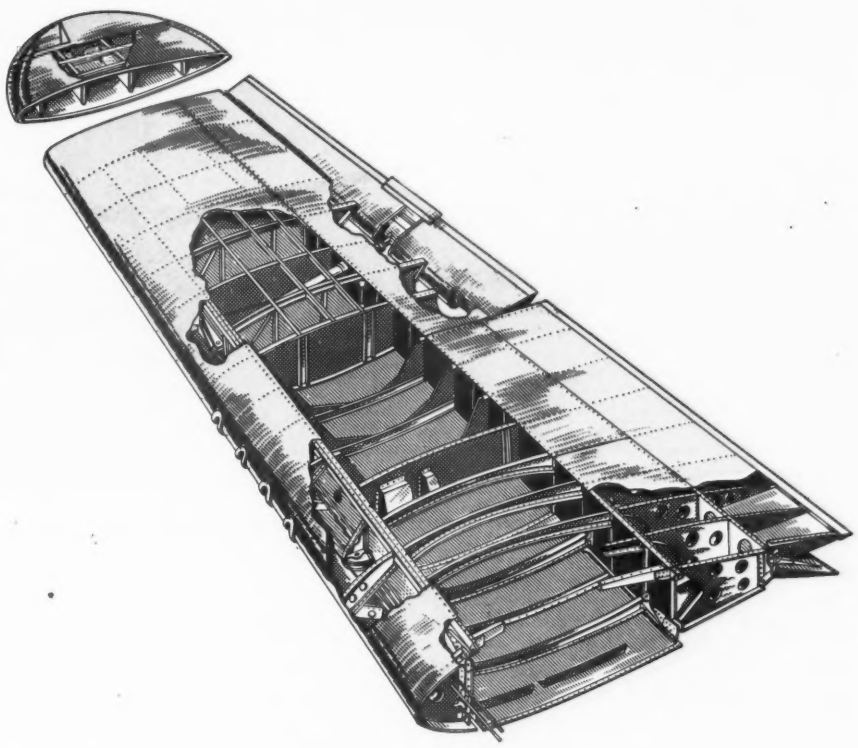
Hatches and Seats

As for the front entry and exit hatch, the front hatch, under the fuselage between front and rear spars, is a door with a double skin of Alclad on Alclad formers. The door is pivoted midway along its length on a tubular shaft supported on two bearings attached to the keel members. Dashpots are provided on either side of the hatch for retarding its movement when used as a parachute exit. The door has a short ladder at the bottom and a foot step with a spring-loaded flap for entry. Catches, holding the door in the open or closed position, are operated by three handles, one under the front fuselage and two inside the airplane. The rear hatch is generally similar.

The pilot's seat takes a seat parachute and is adjustable for height. It is attached to a steel and duralumin tube structure extending from the top boom of the front spar to a keel plate. On the lever on the left side of the seat is an adjusting handle by which the seat can be raised 4 in. As a twist grip on the front end of the handle is rotated, an external cam forces down a spring-loaded sleeve and disengages a locking bolt from a toothed quadrant attached to the tube. Elastic cords at the back of the seat relieve the levers of the weight of the occupant and facilitate raising the seat. On the right side is a lever for collapsing the seat—when pulled up it releases a catch that allows the seat pan and back to be straightened out by pressure from the pilot's shoulders.

The observer's seat takes a seat parachute, and rotates on rollers around a pivot on a duralumin tube mounting. A hand-operated catch on the seat engages with slots in the mounting and locks the seat in either the forward or aft position. Two foot rests are at front and rear.

Front and rear hatches are used as emergency parachute exits. Ground emergency exits are provided by the pilot's knock-out window and pilot's and observer's hoods.



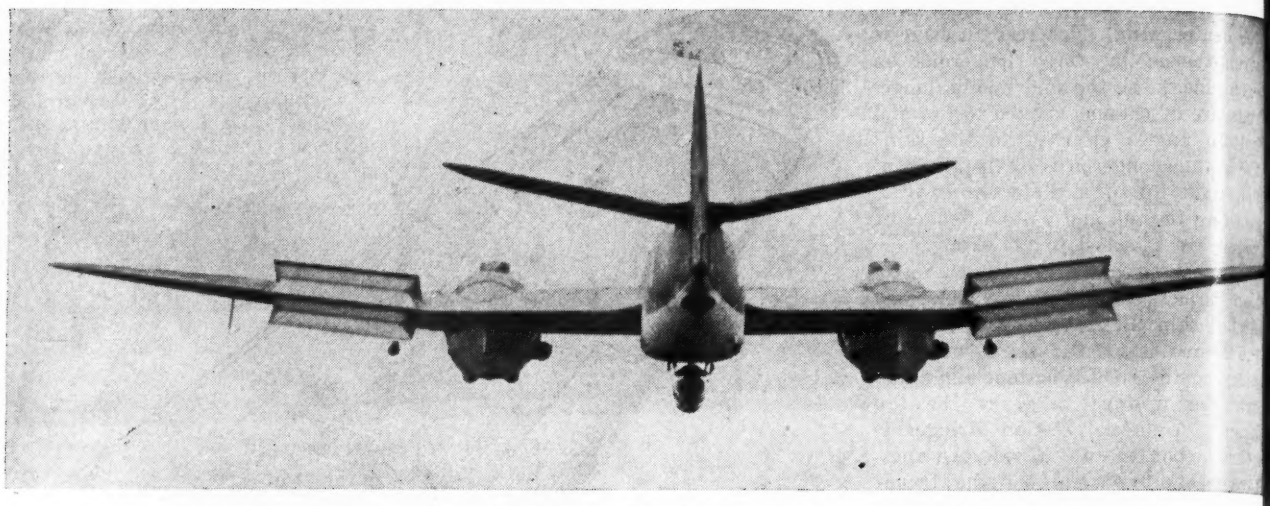
Outer wing consists of two main spars with false spar in front of flap. At inboard end is space for fuel tank, outside which are four machine guns and ammunition boxes. Beyond these is aileron operating mechanism. Aileron is fabric covered on alloy frame. Hydraulically actuated flaps are at inboard end of wing.

Center Wing

The main center wing is a cantilever two-spar metal-covered structure tapered in chord and thickness and constructed in three portions, the center and two outer panels. The center wing spars are continuous through the fuselage and are bolted to it. Hydraulically operated split-trailing-edge flaps are fitted inboard of the ailerons and extend to the fuselage sides. Near the outboard ends of the center wing are mounted structures of steel tube for the engine mounting, nacelles, and undercarriage units. Two fuel tanks are carried in the center section, one on each side of the center line, and single tanks are carried in each outer wing plane. Two landing lights are fitted under a transparent panel in the leading edge of the left outer wing.

The center wing has two spars with Alclad webs and extruded light-alloy booms, Alclad ribs and skin covering, and spanwise skin stiffeners of bulb-angle light alloy similar to the fuselage stringers. The main ribs extend between the spars only, the leading and trailing edge ribs being separate structures. Between the nacelles and the fuselage, the lower leading edge is hinged to permit access to the controls on the front spar. Four fittings are provided on each box rib near the fuselage for attachment of the center wing to the fuselage, and fairing fillets are fitted at the juncture of the two parts and secured by screws to a wood strip under the skin.

Spars have a shear web of Alclad sheet to which extruded light alloy



Rear view of *Beaufighter*, with dive brakes open ready to drop torpedo.

booms are riveted. An angle for attaching the skin is also fitted at the booms. Extruded bulb-angles are riveted vertically to the inner faces of the web for attaching the ribs and for web stiffeners. The ends of the booms have steel bushings for the wing-joint bolts. End fittings are bolted to each side of the booms and a web doubling plate is also fitted near the end of the spar.

Ribs: At each fuselage side Rib 1 is of built-up box form and has horizontal forked blocks of light alloy riveted to the bottom corners and vertical forked blocks bolted to it at the top corners. These blocks have pressed-in steel bushings for the center wing-to-fuselage attachment bolts. Undercarriage attachment ribs have an Alclad web with top and bottom flanges of Alclad lipped angle and are reinforced by a bracing of square light-alloy tubes and vertical bulb-angles.

End ribs each consist of an Alclad plate web with flanged lightening holes and vertical light-alloy stiffeners of bulb-angle and top and bottom flanges of Alclad channel riveted on one side. Remaining interspar ribs, which are without web plate or bracing, consist of top and bottom booms. Top booms consist of channel and I-sections riveted to the skin; bottom ones form bearers for the tanks and are I-section.

Leading edge is of the plate ribs is stiffened diagonally by bulb-angle and supported by similar struts. Upper skin is riveted, while lower forms a hinged door. Ribs are bolted to the spar booms, and skin is riveted to the angle bracket on the front spar.

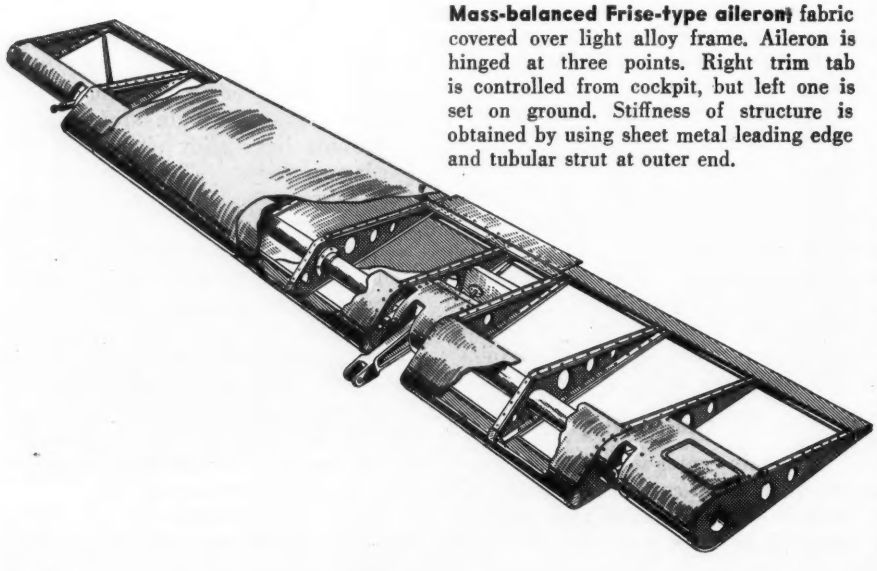
Trailing edge is in two portions, built of Alclad ribs and skin. Ribs are bolted to the spar booms and the skin is riveted to the angle bracket on the rear spar. The after portion, opening on the bottom for the flaps, is secured to a false spar by setscrews and bolts with Simmonds nuts at the aft end of the forward portion. There is also bulb-angle stringer, top and bottom, at about midchord.

Outer wings are generally of similar construction to the center section and are attached to it at the spars. Spar and trailing edge construction resembles that of the center wing. A sealing strip between the center and the outer wings is secured by setscrews. Top booms of the outer wing spars have forked, steel-bushed end fittings which interlock with, and are bolted directly to, the center wing spar end fittings. Similar bottom boom fittings are secured to the center wing spars by bolts and link plates on each side. In addition, the webs of the center and outer wing spars are connected by bolted channels and tie plates.

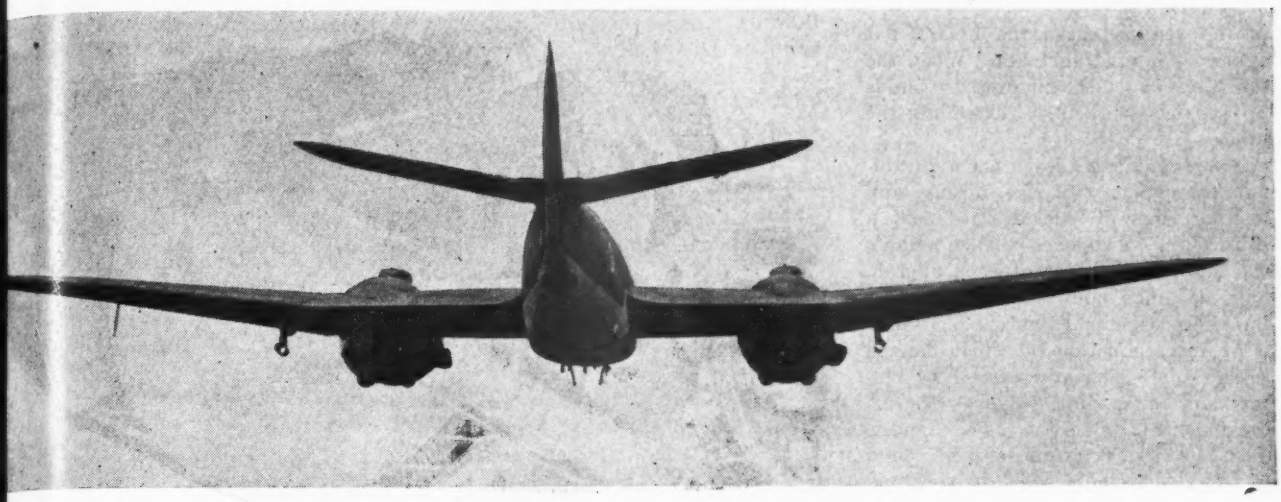
Main interspar ribs have an Alclad web plate stiffened by vertical light-alloy angles and flanges of Alclad bulb-angle. The remaining ribs have top and bottom booms of Alclad channel interconnected by light-alloy bulb-angle. At the fuel tank position, upper and lower booms are similar to those of the center wing.

Leading edge ribs have two overlapped plates stiffened diagonally by flanges and bulb angle with front portions completed by fitting a wood block. Skin of both upper and lower surfaces is riveted to the ribs, which are bolted to the spar booms, while the skin overlaps the angle bracket on the front spar and is riveted to it.

Outer wing tips are of flanged plate construction supported by plate ribs with intermediate ribs of light-alloy bulb-angle and riveted Alclad skin. They are secured by screws to the outermost wing rib and are detachable. The outer end is transparent sheet enclosing the avigation and formation-



Mass-balanced Frise-type aileron fabric covered over light alloy frame. Aileron is hinged at three points. Right trim tab is controlled from cockpit, but left one is set on ground. Stiffness of structure is obtained by using sheet metal leading edge and tubular strut at outer end.

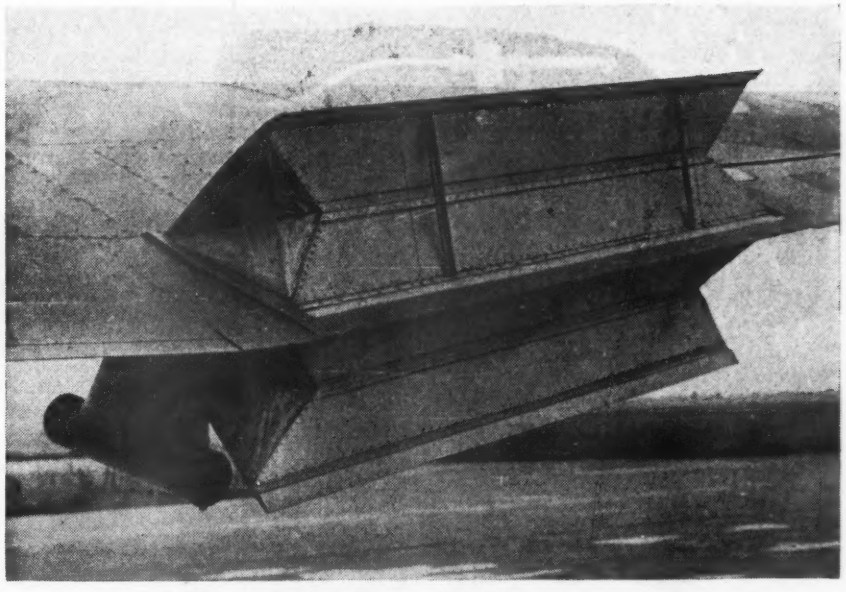


Rear view after torpedo has been dropped and dive brakes closed.

keeping lamps, which are mounted on the outer end rib. A recent modification introduces plastic lamps mounted in tubular brackets to replace the formation-keeping lamps.

Flaps are constructed in four sections—the left and right center and the outer wing flaps—and they extend from the fuselage sides out to the ailerons. They are operated by two hydraulic jacks, the left and right flaps being interconnected by balance cables for simultaneous action. Flaps are mainly of Alclad and have channel ribs, a Z-section spar at the forward face, channel transverse stiffeners near mid-chord, and a rectangular tube trailing edge. Brazier head rivets secure most of the bottom skin to the ribs, stiffeners, and spars. Chobert rivets are used on the top and in the last three rows on the bottom. The lower skin projects beyond the trailing edge and, when the flaps are raised, closes the rear gap beneath the wing. Piano hinges on the bottom of the flap spar connect the flaps to the false spar of the wing. A duralumin horn is bolted to the outboard end of each center flap and to the inboard end of each outer flap.

Dive brakes: Torpedo - carrying *Beaufighters* have a speed above 300 mph. and, while the precise technique of dropping torpedoes from high-speed aircraft is very secret, it is generally known that they may be released from heights up to about 150 ft. and that the maximum aircraft speed at the drop should not exceed about 180 mph. To give a quick change from the high speed approach to the slow dropping speed, special bellows airbrakes are fitted. Immediately outboard of each engine is a venturi tube with a butterfly throttle at the rear end. This tube is connected to the air brakes, and when the throttle is open, the partial vacuum

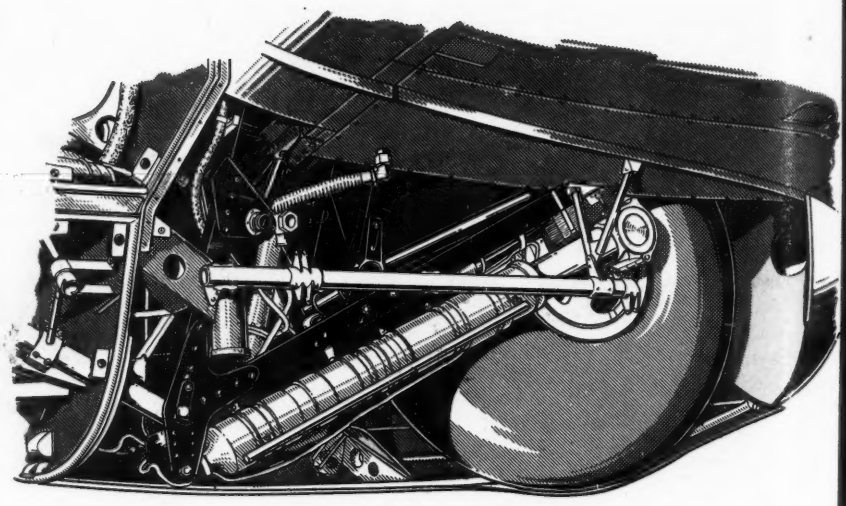


Dive brakes are operated by venturi tube beneath wing. When damper at back of tube is closed, air pressure opens brake bellows. When damper is opened, venturi suction draws bellows together to conform with wing surface. Braces are inserted in top bellows to hold open for photographic purposes.

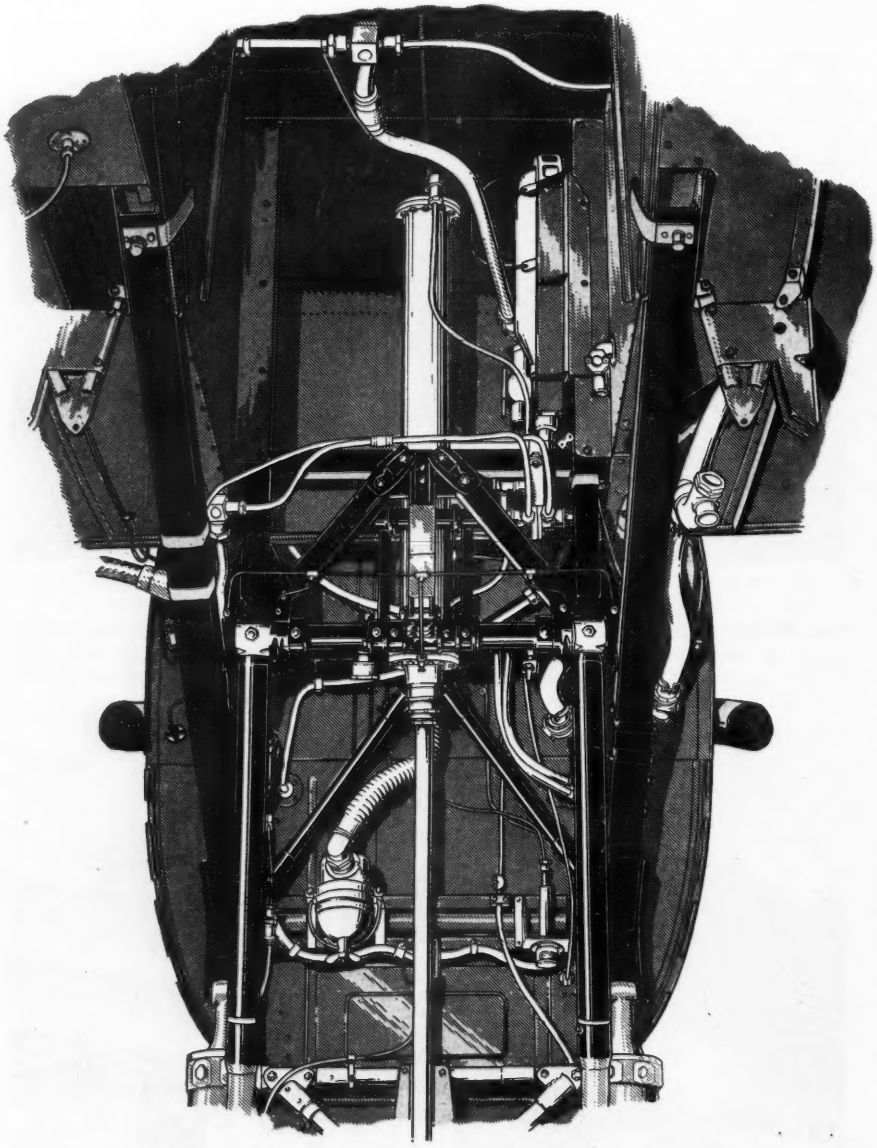
in the venturi sucks the brakes flat against the wing surfaces. When the throttle is closed the air pressure builds up and fills the bellows, extending the brakes.

Ailerons: Each aileron has a duralumin tube spar, with ribs, nosing, and trailing edge of Alclad sheet and a fabric skin. Two mass-balance weights are fitted in the nose of each aileron, and the hinge points are inset to obtain aerodynamic balance. The spar is of duralumin tube on which flanged Alclad plate ribs are secured by collars and taper pins. Eyelets for attaching the fabric are in the rib flanges. The Alclad sheet nosing is bent round and riveted to the nose of the ribs, and the lead mass-balance weights are riveted inside along its entire length.

Outboard and inboard of the trimming tab, the trailing edge of Alclad sheet is riveted to the ribs. A duralumin tube, from the rear outboard corner to an eyebolt through the spar, reinforces the outboard end of the aileron. Three ball bearing hinges on each aileron are attached to special tail ribs on the outer wing.



Retracted landing gear. Large cylinder—one each side of wheel—is oleo strut shock absorber. Heavy triangular frame attaches gear to front spar and wing rib. One fairing panel has been removed to show mechanism.



Landing gear hydraulic cylinder as seen from rear, when looking forwards and upwards, gear extended. Jointed radius rods, which hold gear in down position, are hinged onto cross member in center. Carburetor and induction system priming pumps, accessible only when gear is lowered, are seen inside cross members.

Trimming tabs: The tab on the left aileron is made of light gage stainless steel sheet secured by countersunk screws on the top and by round-head screws in elongated holes on the underside, thus allowing a small amount of adjustment for lateral trimming to be made on the ground. The fabric of the aileron passes round the former to which the tab is secured but does not pass over the tab.

The trimming tab on the right aileron, operated from the cockpit, is of Alclad sheet bent to shape and hinged to the trimming tab former. A horn is fitted to the underside of the tab.

Landing Gear

There are two independent undercarriage units and a tail wheel unit making up the landing gear, all simultaneously raised or lowered by hydraulic power, the undercarriage units swinging backward and upward into the nacelles and the tail wheel forward and upward into the underside of the stern frame.

Indicating and warning devices include three electrical position indicators, one for each unit, and an electrical buzzer. Oleo-pneumatic shock-absorber legs are fitted both the undercarriage (either Vickers or Lockheed) and to the tail wheel. Dunlop brakes are used on the undercarriage.

Undercarriage: Each unit has a single wheel on an axle between two shock-absorber units cross-braced to

form a rigid frame. The frame is connected to the nacelle at pivot points at the top of the shock-absorber and is braced in the down position by a pair of knee-jointed radius rods, the upper portions of which are fixed to a transverse torque shaft supported in bearings on the rear tubes of the nacelle structure.

When the undercarriage is retracted, nacelle doors, shut by shock-absorber cords, fair the gap at the bottom of the nacelle, completely enclosing the undercarriage and wheel. A catch, operated by levers and Teleflex controls, is interconnected to the hydraulic selector lever. When the undercarriage is retracted and the hydraulic selector lever is returned to the "off" position, the catch locks the doors.

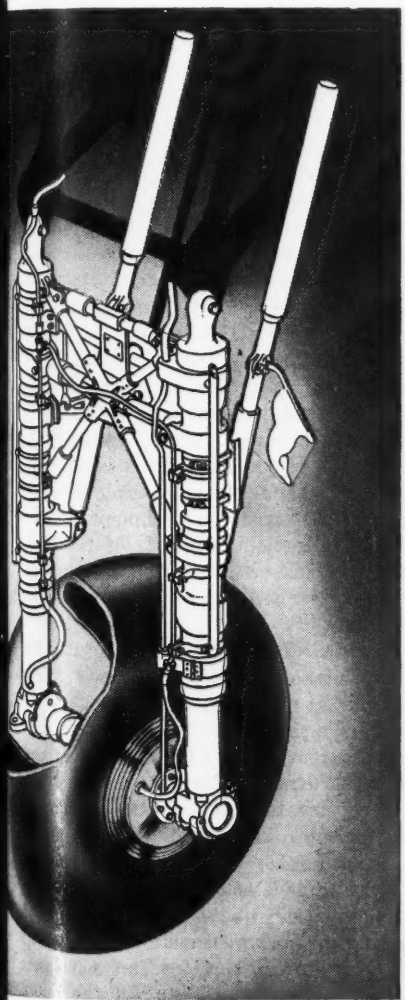
Empennage

The tail comprises a cantilever stabilizer and fin, elevators, and a rudder. On later models the stabilizer has a pronounced dihedral of 12 deg. Early planes have no dihedral. All-metal construction is employed for stabilizer and fin, while elevators and rudder have metal framework and fabric covering. Rudder and elevators have inset trimming tabs, and each elevator has a balance tab. Stabilizer attachment fittings, extending to the upper surface, also serve as fin attachment points. Stabilizer and fin are faired, at the juncture with the rear frame, by fillets secured by woodscrews to wooden fairing strips on fin and frame.

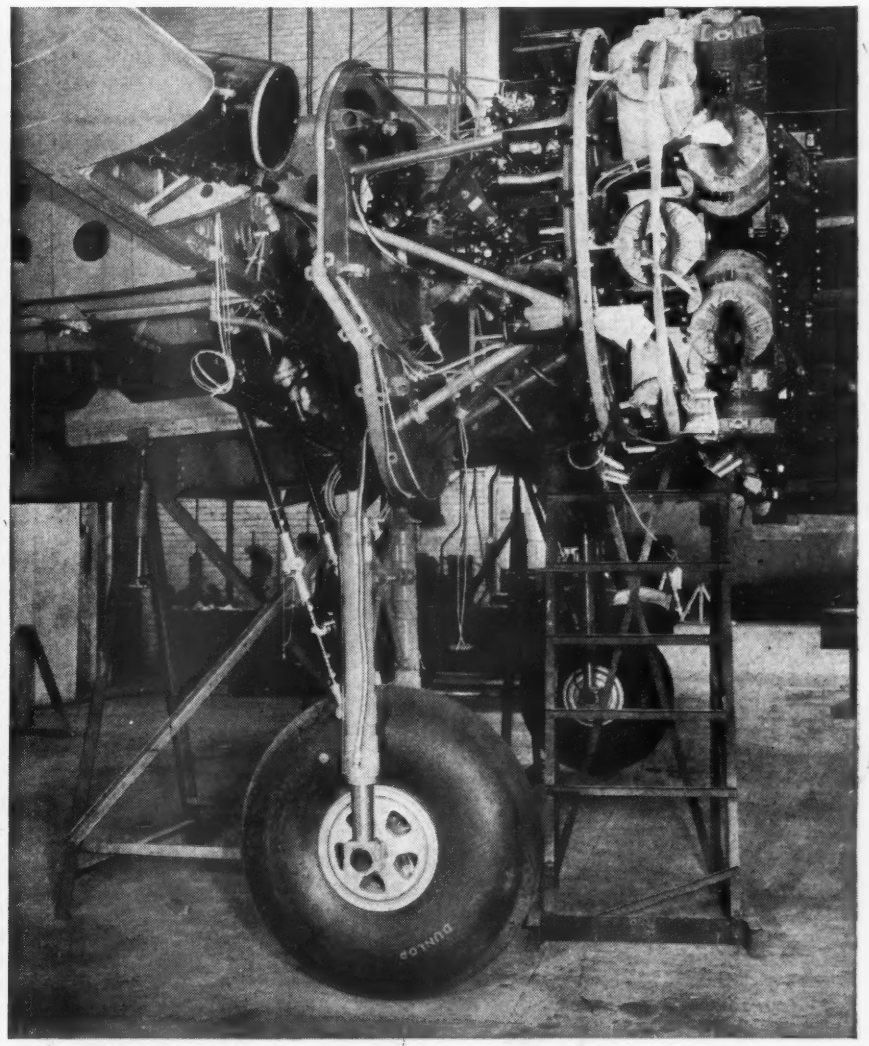
Stabilizer: Early planes had a stabilizer built in one piece. In later models it is built in three pieces, a small center and two outer panels. The outer panels are riveted to the center section. Construction of both types is similar. Two Alclad channel spars, with extruded light-alloy booms riveted on as reinforcements for the flanges, flanged Alclad sheet ribs, and Alclad skin covering, form the tail plane structure. Between the spars, the skin is stiffened by transverse stringers, and aft of the rear spar, inboard of the cutaways for the elevator balance portions, a false spar is fitted. On either side of the stabilizer center-line, a steel inter-spar tube between the stabilizer-to-fuselage attachment fittings reinforces the structure.

An inspection door is in the upper surface. Elevator hinge bearings are on two brackets, one secured to the rear spar and false spar on the stabilizer center-line and one on each outer panel inboard of the elevator cutaways. The stabilizer tip edge is of wood, secured by woodscrews to the skin overlap.

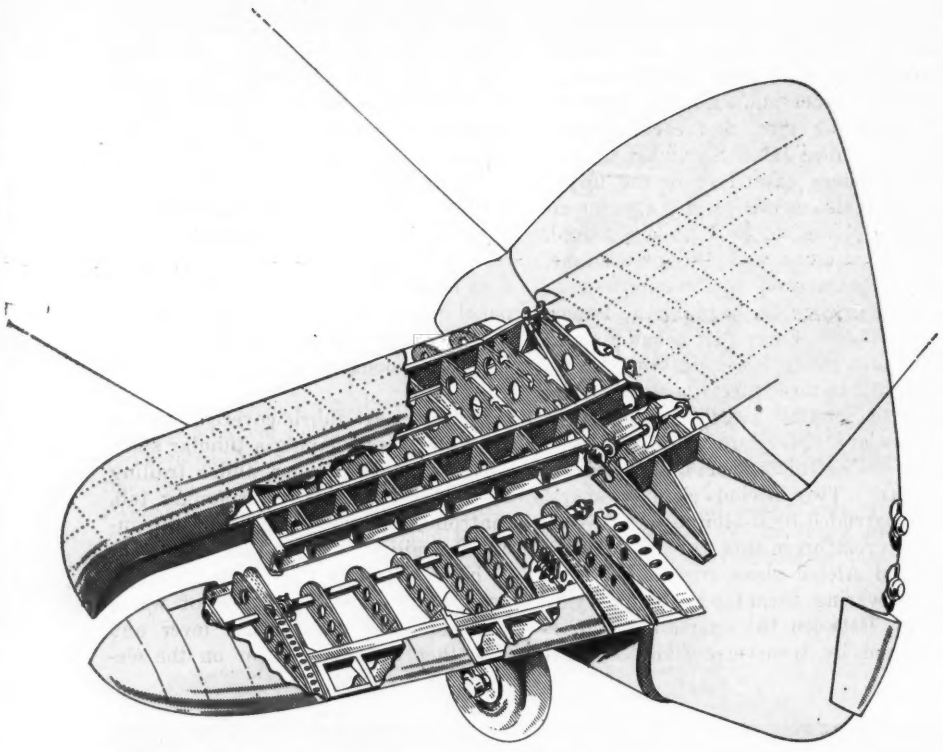
Elevators are fabric covered, built in separate halves, having a tubular spar, Alclad ribs and nosing, and a trailing edge of oval tube. A trimming tab, controlled by the pilot, is in the inboard trailing edge of each elevator. A balance tab in the trailing edge is operated by a rod, one end of which is attached to the balance lever and the other to a fixed lever on the ele-



Light loads are cushioned by air, heavier loads by hydraulic loading. Brakes are pneumatically operated. Warning flag indicates when safety lock is on, preventing gear from being raised.



Nacelle framework, with engine and landing gear in position. Oil cooler is at upper center in line with leading edge. Bristol *Hercules* engine is used, mount being attached to three points on spar and two on nacelle frame.



Elevator and stabilizer are of conventional design. There are two tabs on each elevator, outboard for balance and inboard for trim. Elevator is fabric covered; remainder is of stressed skin construction.

vator outboard end bearing bracket.

The steel tube spar has a sleeve and liner at the outboard hinge and a flanged extension bolted at the tip. The ribs, of flanged Alclad with flanged lightening holes, are secured to the spar by collars fastened by Chobert rivets. Eyelets for fabric are in the flanges. An oval steel tube forms the trailing edge outboard of the trimming tab. From the inboard end to the balance portion, the nosing is of Alclad sheet riveted to the ribs. The balance portion is covered with Alclad, with a wooden nose fillet held by woodscrews. Mass-balance weights are secured to the nose. A fairing of aluminum-manganese sheet is fitted at the inboard end of each elevator, aft of the Alclad nosing. Fabric covering extends round both the balance portion and the nosing.

The elevator horn is bolted to a socket on the inboard end of the spar. The pin for the final connecting tube from the elevator control passes through both the left and right levers and (with a bolt and distance piece and two packing blocks between the levers) interconnects both elevators. A spigot at the inboard end of each spar centers in a ball bearing on the stabilizer bracket and forms the center hinge. Outboard hinge has two split bearings in which the spar rotates.

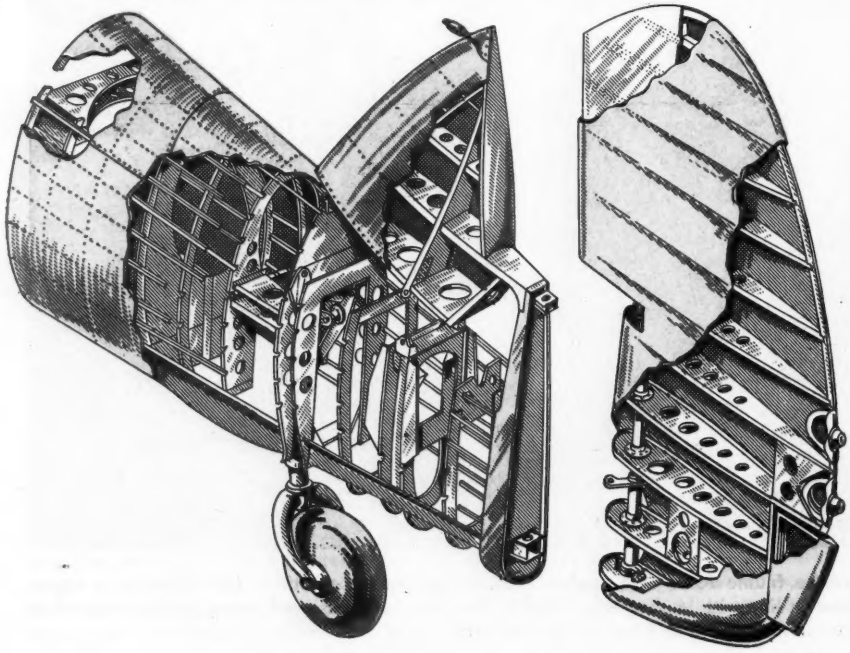
Elevator trimming tabs: A tubular light-alloy spar, Alclad ribs and skin, and an oval tube trailing edge form the construction of both trimming tabs, which may quickly be detached and which are fitted with mild steel hinge pins in slots at the spindle ends.

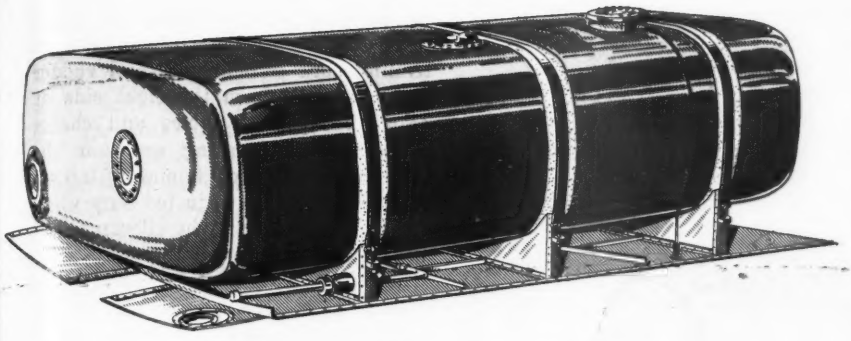
The fin has front and rear posts and a rear member of channel-section. Alclad is used for the above, also for ribs and skin, but the nosing is aluminum-manganese sheet. Front and rear posts are reinforced at their lower ends to form box-sections to which the steel-bushed fin attachment lugs are bolted. The front lugs are bolted directly to the stabilizer front spar, while the rear lugs are connected through links to the rear stabilizer fittings. A rearward extension of the second rib from the fin base is bolted to the rear post.

Secured by setscrews, a removable panel covers the gap between the bottom rear channel and sternpost. This is a mahogany-filling piece inside the top rear channel member, and there is a spruce strip for attachment of the fairing fillets on each side of the bottom rib. The steel aerial attachment bracket is riveted to the apex of the fin.

Rudder: In construction, the rudder is similar to the above. An inset trimmer tab is controlled by the pilot. The spar is a light-alloy tube with a flattened extension near the tip. Ribs and their attachments are similar to those of the elevator. Above the trimming tab and up to the top of foremost point of the balance portion, the trailing edge is mild steel tube, but below the trimming tab it is light-alloy. The nosing and balance portion are similar to those on the elevator; mass-balance weights are bolted under the nose fillets. A fairing of aluminum-manganese is secured to the rudder bottom by Chobert rivets. In the trailing edge are two tail lamps, with the cables running in conduits along a rib and

Stern frame, rudder, and fin. Fin is of stressed-skin, light-alloy construction and rudder is hinged on heavy sternpost. Aerial attachment is on fin. Trim tab is in fabric covered rudder. Oleo pneumatic tailwheel retracts forward into fuselage through trap.





Welded aluminum fuel tanks have self sealing covering to protect plane from fire hazards.

through a door in the nosing. The fabric covering extends right round the nosing and balance portion. Inspection doors are on the left side at mass-balance weights and trimming tab actuator, also on right side, at rudder horn.

The rudder is hinged at two points by double split bearings bolted to the sternpost. The horn is in halves bolted to a socket on the spar above the bottom hinge.

Rudder trimming tab: This is of the same construction as the elevator trimming tab and is mounted in the same manner. The horn is fitted on the right side at the bottom and is linked to the actuator in the rudder.

Flying Controls

Pendulum rudder pedals and the spectacle control column are connected to their control surfaces by chains and cables. A trimmer tab, adjustable on the ground, is fitted to the left aileron and, for directional control, there are longitudinal and lateral trimmer tabs controllable by the pilot in the rudder, elevators, and right aileron. The flaps are hydraulically operated.

The control column, pivoted on a box bracket on the control frame, consists of a light-alloy tube on which is bolted the control column head, which is in two halves with a ball bearing for the spectacle aileron control handwheel. At the center of the handwheel are the undercarriage brake lever and parking lock, and at the top right is the gun firing button. A sprocket is on the handwheel spindle and from it a chain extends down the control column and over two ball bearing pulleys on the mounting bracket behind the column pivot. A socket on the bottom of the control column is secured to spigots pivoted on ball bearings in the mounting bracket. The elevator control lever, riveted to the socket and spigots, extends below the mounting bracket. Adjustable stops are at the forward and after ends of the bracket.

Rudder pedals pivot on a transverse support tube between the sides of the fuselage and are of stirrup form with leather toe-straps. Each pedal lever, near mid-length, is connected by a link to a lever turning a vertical countershaft, at the bottom of which is an outboard-pointing lever. For leg-reach adjustment the two levers at the top of the countershaft are fixed to a sliding trunnion which can be moved backwards by a crank below the instrument panel to give 3 in. adjustment to the pedals, either side of normal.

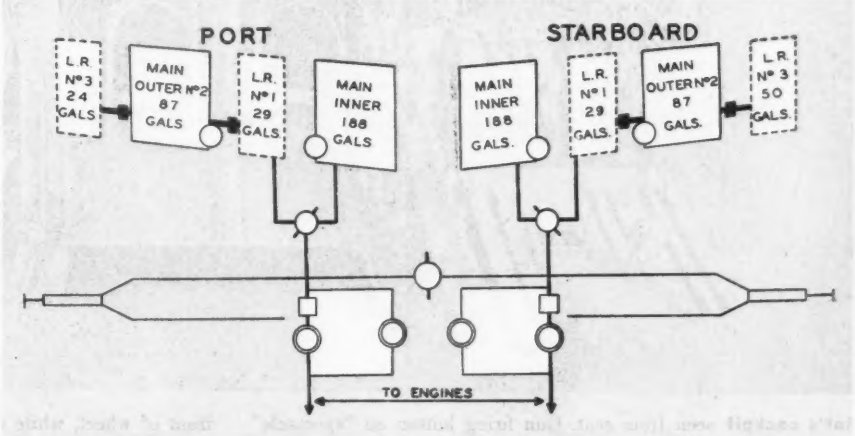
Elevator control: From the lever at the bottom of the control column one cable passes forward and around a pulley on the rudder and elevator torque tube and another passes aft to a pulley assembly (mounted on the control frame) and then to a pulley assembly on the front keel member forward of the front spar. From there the cables, with turnbuckles at the rear hatch, extend inboard along the left keel member over pulleys aft of the crate in the rear fuselage to a central vertical double countershaft in the stern-frame carrying the ball bearing elevator levers for rudder control. From this countershaft, movement is transmitted by an adjustable connecting tube to a horizontal countershaft and to the elevators by an adjustable connecting tube to which the horns for the elevators are secured by a special bolt.

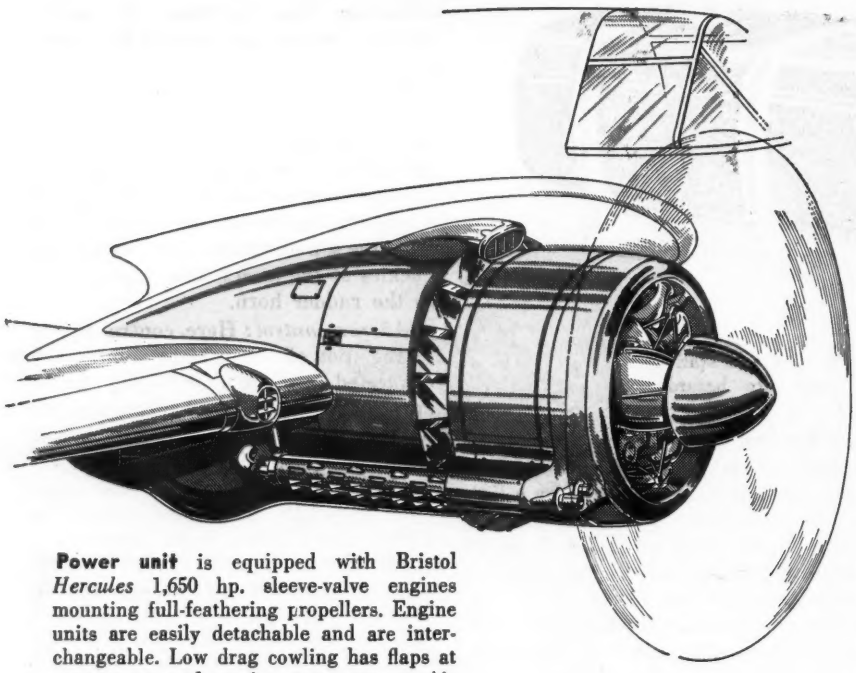
Rudder control: From the lever at the bottom of the rudder pedal vertical countershaft, movement is transmitted by a connecting tube to the rudder and elevator torque tube, thence by a cable to the sternframe countershaft from the top of which cables, with turnbuckles at the levers, lead over pulleys to the rudder horn.

Aileron control: Here, control chains at the foot of the control column are connected by another chain to a sprocket on the aileron relay post aft of the control frame just forward of the front spar. Chains and cables extend outboard from the four quadrants over sprockets and pulleys (on the front face of the front spar) to a point between ribs 11 and 12, where their directions turns towards the ailerons. Turnbuckles for adjustments are fitted between the control column and the relay post, also just outboard of the outer and center wing joints. A telescoping conduit encloses the chains and cables between the spars. The final chain passes over the sprocket behind the rear spar and around a sprocket on the differential gear.

Two special tail ribs behind the rear spar support the aileron differential gear. This consists of a sprocket on the inboard tail rib which has an integral differential lever that is connected by a link to the aileron horn. A lever on the outboard tail rib also supports the connecting link. The top pivot point of the connecting link in the neutral position of the aileron is mounted above the horizontal line through the sprocket center so that, for the same rotation on either side of neutral, the vertical movement of the pivot point and angularity of the aileron is greater when the aileron is being

Fuel supply is maintained by engine-driven pumps. Tube systems are connected by suction balance pipe with pilot-controlled cock. Fuel is filtered forward of firewall. L. D. (long distance) extra tanks are fitted when required.



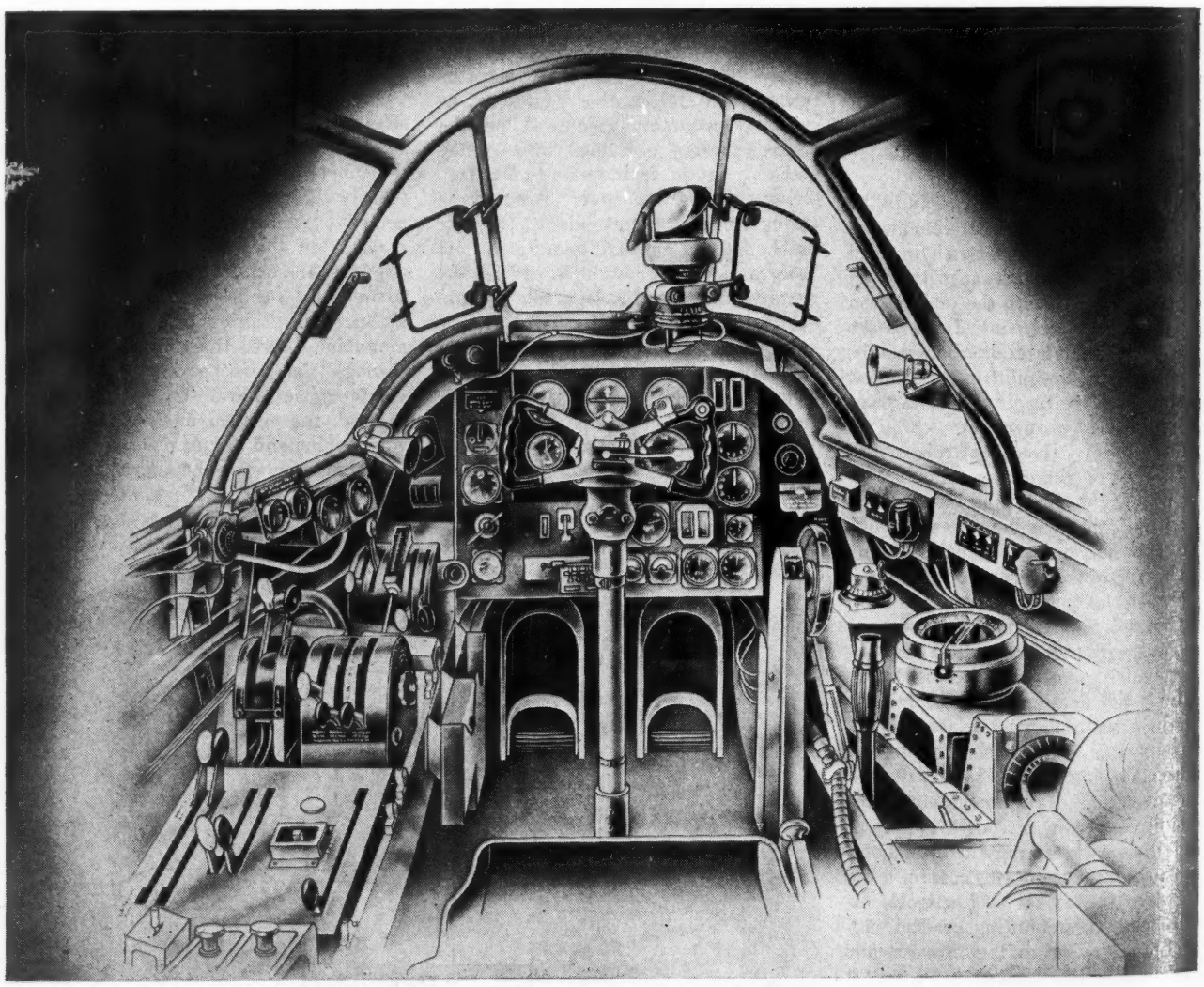


Power unit is equipped with Bristol *Hercules* 1,650 hp. sleeve-valve engines mounting full-feathering propellers. Engine units are easily detachable and are interchangeable. Low drag cowling has flaps at rear to control engine temperature. Air scoop for oil cooler is above engine at rear.

raised than when lowered in flight.

Trimming tab controls: Tabs in trailing edge of elevators and rudder are controlled from the right side of pilot's cockpit by cables and chains connected to actuating units at the sternframe. Aileron trimming tab on left aileron can be adjusted only when on the ground, but right aileron tab is controllable by the pilot.

Elevator tabs: The tab control wheel is atop the column on the right side of pilot's cockpit, and it operates (by a chain) a drum at the bottom of the column from which cables extend along the right keel member to just forward of tail wheel. Here the cables are connected by turnbuckles to chains (on later models Teleflex cables) that operate a drive unit behind the stabilizer rear spar, whence flexible drives go to a screw jack or actuator at the inboard end of each elevator and coupled directly to the tab horn by an adjustable rod. An indicator is mounted partly on the starboard shelf



Pilot's cockpit seen from seat. Gun firing button on "spectacle"-shaped steering wheel. Blind flying instruments are directly in front of wheel, while trim tab controls and compass are on right and engine and hydraulic controls on left.

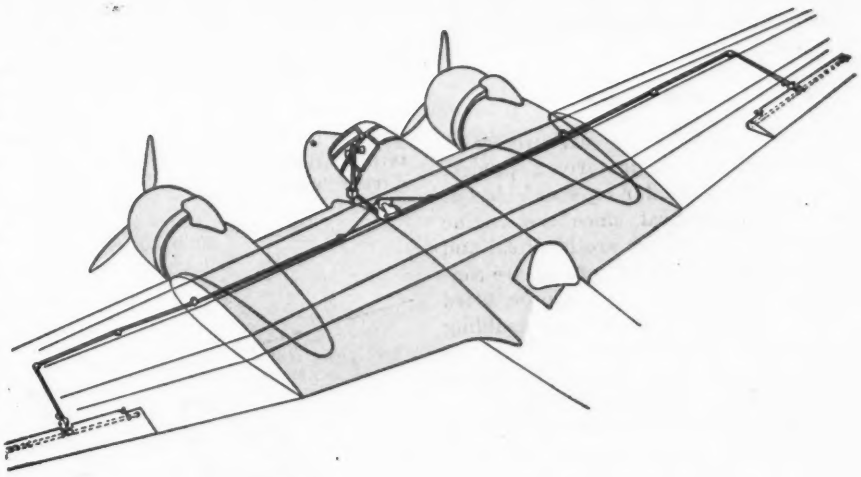
and partly on the aft side of the column supporting the handwheel.

Rudder tab: Here, the tab control handle and indicator is mounted on the right shelf in the pilot's cockpit and is connected by bevel wheel and torque shaft to a drum from which cables and chains (on later models Teleflex cables) connect to a drive unit from which a flexible drive operates an actuator coupled to the tab horn by an adjustable rod.

Aileron tab (right): The aileron tab control handle and indicator is mounted on the right shelf in the pilot's cockpit in line with the seat back and is connected by cable to a pulley and sprocket (on the rear face of the rear spar, right side) whence cables and chains drive an actuator mounted behind the aileron spar and coupled to the tab horn by an adjustable rod.

Flap operating gear: The two flaps on each side of the main plane are operated by a hydraulic jack pivoted on the rear face of the rear spar inboard of the center and outer wing joint. The piston rod of the jack is coupled to the bottom of a quadrant pulley on a support frame behind the rear spar, with two links at the top of the pulley connected to the operating levers of the flaps. A cable round the quadrant pulley is connected by chain to a small sprocket on a relay shaft further inboard. From the large sprocket on the relay shaft, chains and cables extend across the center plane and interconnect the flaps on each side so that they are raised and lowered simultaneously.

The lever for flap control is on the left side below the pilot's instrument panel. An indicator, showing the position of the flaps, is connected by Teleflex controls to a lever on the flap hinge at the left side of the fuselage.



Aileron controls operate through chains from steering column to control frame forward of front spar. Chains and cables extend outwards and turn around pulleys towards ailerons. From pulley to aileron differential gear, controls pass through telescopic casing. Final control is from differential gear to aileron horns.

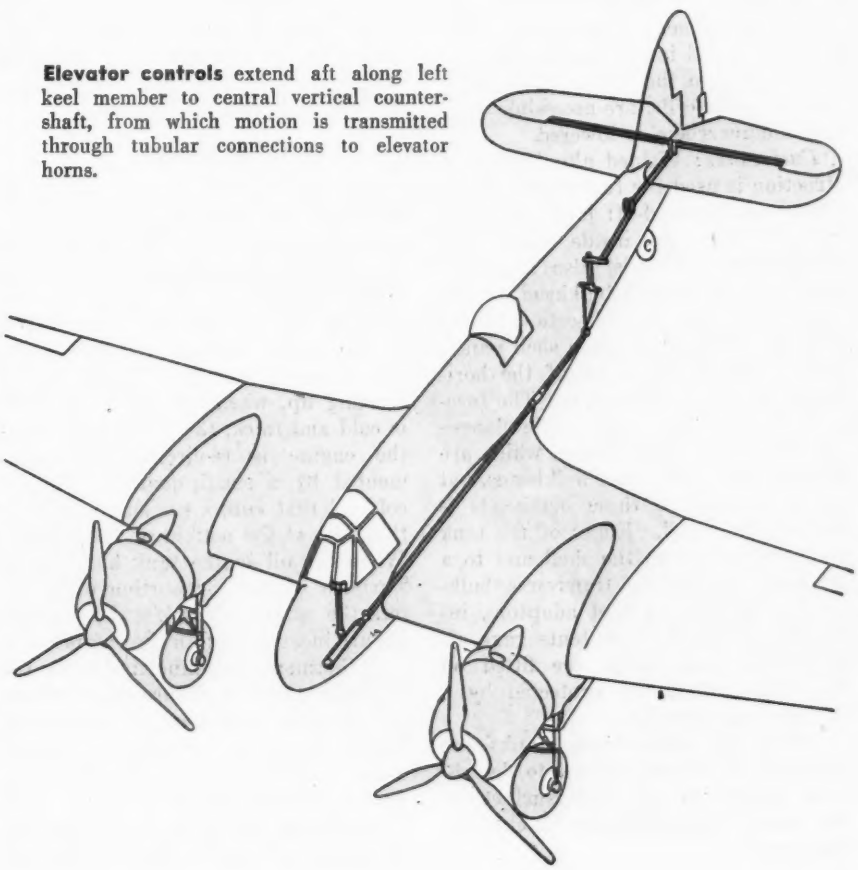
Engine Installation

Two *Bristol Hercules* engines are fitted in nacelles near outboard ends of the center plane. The nose of each cowling is formed by an exhaust collector ring, while the flow of air is controlled by flaps at the trailing edge. Fuel is carried in four main tanks, two in the center wing (one on each side) and one in each outer wing. The fuel is fed to the carburetor by engine-driven pumps.

An oil tank is fitted for each engine on the top of the wing at each nacelle, and separate oil coolers are mounted in the outer wings. To assure an adequate supply of oil when starting, a high initial oil pressure device is incorporated in each engine. The engines are fitted with electric starters, and for maintenance work, hand-turning gear is provided. Constant-speed feathering Hydromatic propellers are fitted.

Engine Mounting: Each power plant mounting is of welded steel tube attached to the main structure, near the outboard ends of the center wing, at five points, three on the front spar and two on the nacelle structure. The tubes at the rear attachment joints are split, wrapped around, welded to a steel bushing, and a steel gusset plate is welded over the joint. The engine ring is bolted to four points on the engine mounting, joints being formed by a steel barrel to which the tubes are secured by welding, and steel gussets. The engine ring is a steel tube of square section with welded steel side

Elevator controls extend aft along left keel member to central vertical countershaft, from which motion is transmitted through tubular connections to elevator horns.



plates and bushings for the ring attachment and for the seven engine attachment points.

Fuel System

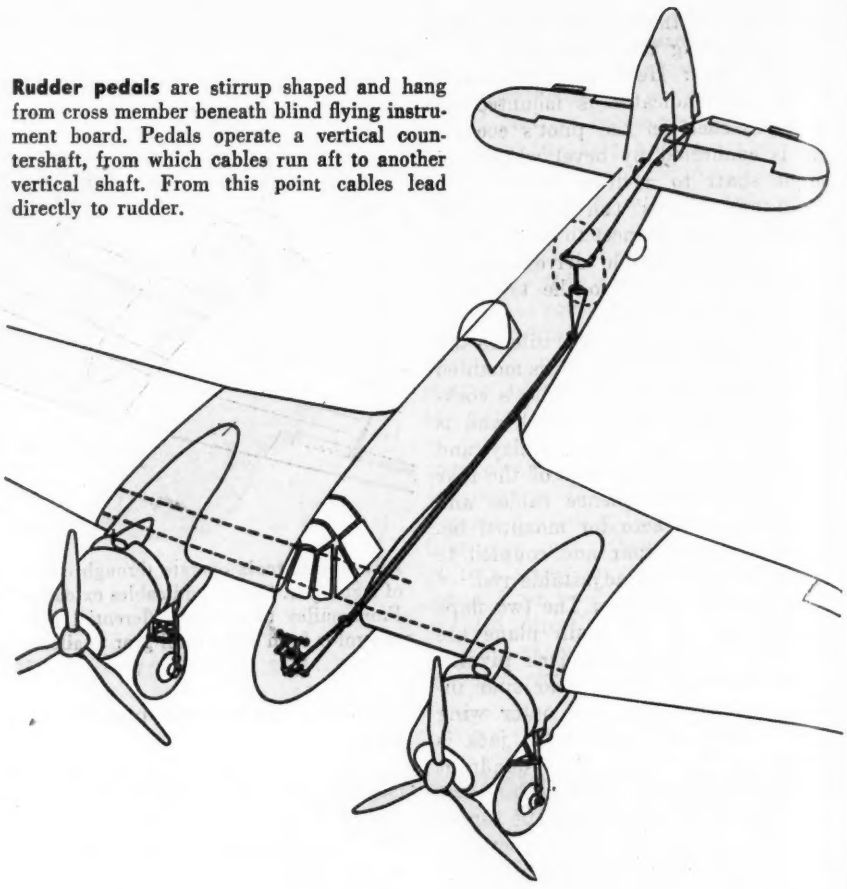
Fuel supply to the carburetors is maintained by engine-driven pumps. The system is similar on each side but is not symmetrical since the engine rear cover assemblies are identical and not handed. The tube systems are connected by a suction balance pipe, fitted with a pilot-controlled cock, enabling fuel to be drawn from any tank to either engine. Pipe-lines are of copper Superflexit or light-alloy tubing.

Fuel is drawn from each tank in turn through a cock on the tank, wired open, to a pilot-controlled 3-way cock in the nacelle. From here, fuel passes to a filter forward of the firewall. The suction balance pipe connection is made at the engine side of the pilot-controlled cock located in the leading edge of the center wing between the fuselage and the left engine. The engine pump draws fuel from the filter and delivers it through a pressure regulator to the carburetor. A connection for the fuel pressure gage is made at the carburetor and for the priming system at the filter.

Two main fuel tanks are carried between the wing spars on each side. Fuel gages for each tank are in pairs, one pair on the left sill tube and the other on the right. Fuel pressure gages are on the instrument panel below the right of the instrument-flying panel. The carburetor and induction-system priming pumps, on the bottom cross members of the nacelle, are accessible when the undercarriage is lowered.

Fuel tanks: Welded aluminum construction is used for fuel tanks. Transverse and fore-and-aft bulkheads with flanged holes are inside each tank. Transverse bulkheads, also an intermediate fore-and-aft bulkhead on the outer wing tank, have T-section flanges with the edges of the main shell panels butt-welded to the edges of the horizontal part of the T-sections. The fore-and-aft bulkheads have angle flanges on both sides of the plates, which are riveted to the transverse bulkheads, but no attachment of these bulkheads is made to the shell. Edges of the tank ends are welded to the shell and to a strip on the middle transverse bulkhead. Filler caps, vent adaptors, inspection doors, fuel contents gage attachments, and sumps are fitted on the tanks, which are protected by a self-sealing covering.

Outer and center wing tanks are strapped to bearers riveted to detachable panels on the undersurface of the wings and bolted to brackets at the spars.



Rudder pedals are stirrup shaped and hang from cross member beneath blind flying instrument board. Pedals operate a vertical countershaft, from which cables run aft to another vertical shaft. From this point cables lead directly to rudder.

Jettison equipment: A jettison valve is under the outer tanks, and is operated pneumatically from the instrument panel. Fuel is jettisoned through piping under the outer wing. On later models, provision is made for jettisoning the fuel from all the tanks.

Oil System

The feed pipeline to the engine leads from the tank sump direct to the pressure pump on the engine. Return oil passes through an oil cooler on struts at the inboard end of the outer wing leading edge. From the forward end of the cooler, the oil returns to the top of the hopper in the tank. After starting up, when the oil in the tank is cold and thick, the warmer oil from the engine is re-circulated, supplemented by a small quantity only of cold oil that enters the sump through the holes at the bottom of the hopper. When the oil in the tank has become warm, a greater proportion of it enters the sump. Centrifugal oil clearers are incorporated in the engines.

A thermometer connection is on the feed pipe, and a pressure gage connection is made on the engine rear cover. Excess length of the tubing is wound round a spool mounted inboard of the nacelle behind the firewall. A cock for draining the oil system is fitted in the main feed pipe behind the firewall.

The oil cooler is of the two-element drum type. Each element of the cooler has a separate relief valve which bypasses the oil around a jacket outside the cooling tubes if the pressure exceeds a certain figure. Each relief valve has a different setting which is clearly marked on it. Air is collected by an opening forward of the cooler and is exhausted through the top surface of the center wing just forward of the front spar. The air outlet opening is adjustable on the ground.

Oil tanks: Each oil tank is constructed of welded aluminum and is strapped to the top of the center wing under the engine nacelle top panel. Inside the tank are two transverse bulkheads in line with the straps; they are not attached to the shell but are tightly fitted. Vertical fore-and-aft bulkheads are fitted between the transverse bulkheads. A hopper, having large diameter holes in its lower end, extends from the top of the tank to the sump at the base. The oil return enters the tank at the bottom near the front and is connected to the top of the hopper. The filter in the sump of the tank may be withdrawn through the cover of the hopper. In this tank the filler cap is situated in such a position that the tank cannot be over-filled, and it also assures the correct air space. A dipstick is provided adjacent to the

filler cap for gaging depth of fuel.

Engine Controls

Throttle, mixture, propeller speed, supercharger, and air-intake controls are mounted on a shelf on the left side of the pilot's cockpit. The carburetor cut-out controls are mounted on the top of the front spar, on the left side of the cockpit under a spring-loaded cover. Cowling flap switches are mounted on a sloping panel between the engine control shelf and the carburetor cut-out-box.

Throttle and mixture levers are connected to rods in the engine nacelles by push-pull rods and torque tubes in Oilite and ball bearings along the nose of the wing. Carburetor cut-out knobs and the air-intake, propeller, and supercharger control levers are connected to their respective engine levers by Teleflex controls. The cowling flap switches operate electric motors mounted on the right-hand side, (looking aft), of the engine nacelle.

Auxiliary gear boxes: An auxiliary gear box is mounted on the firewall in each engine nacelle and is driven from the engine by a flexible jointed shaft so constructed that the generator drive face is positioned vertically. The accessories driven by gear boxes are:

1. Generator (top face), Pesco B.3 vacuum pump (inboard face), and hydraulic system pump Mark IV (outboard face).

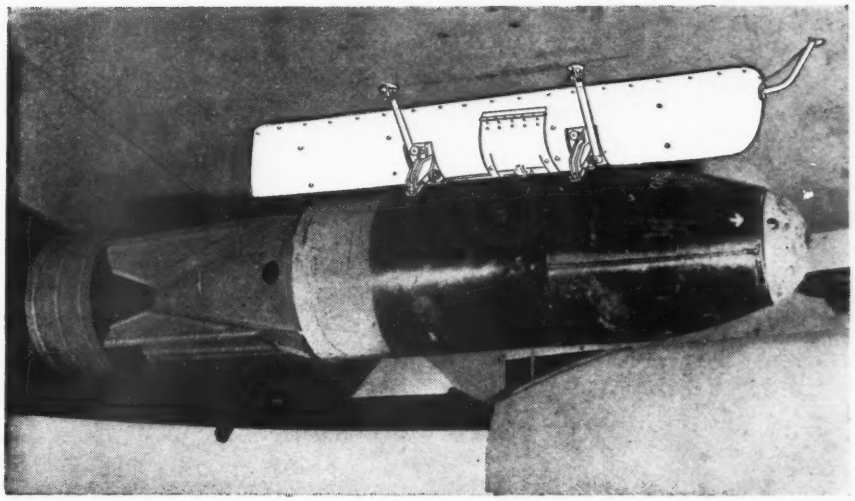
2. Generator, air compressor (rear face), Pesco B.3 vacuum pump (outboard face), and hydraulic system pump Mark IV (inboard face).

Ignition

The two magnetos on each engine are controlled by separate switches combined in one unit below the instrument-flying panel in the pilot's cockpit. Switch knobs are prevented from being moved to the "on" position by an extension bar on the switch for the undercarriage and tail wheel electrical position indicators (mounted alongside on the left side) when that switch is off.

A booster magneto on a bracket forward of the firewall supplies starting current to the main magnetos. In the H. T. cables connecting the booster to the main magnetos are spark gaps which relieve the booster windings when the engines are running normally. A tumbler switch, mounted in each engine nacelle above the undercarriage pivot and accessible only when the undercarriage is "down", controls the starting magneto. The hand turning gear is also connected by a chain drive to the starter magneto.

Two temperature gages are mounted on the pilot's instrument panel alongside the magneto switches showing the temperature of No. 8 cylinders.



Bomb in electrically operated rack on bomb-carrying *Beaufighter*.

Extra Tankage

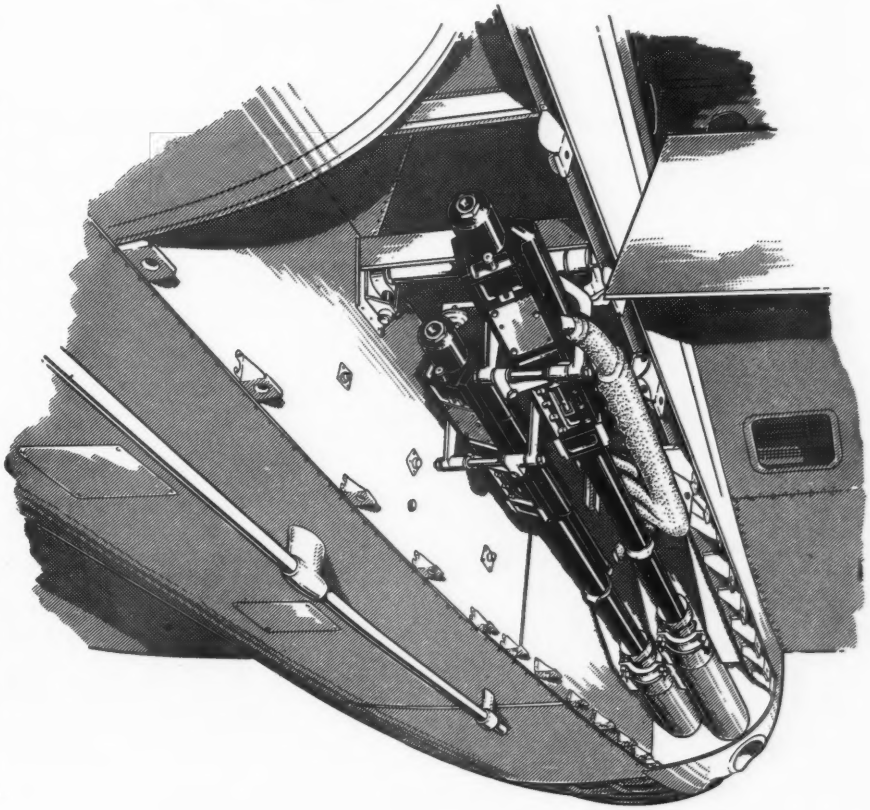
For long-range flying, such as coastal patrol and convoy work, provision has been made for additional fuel tanks in the wings. They are arranged as follows: One 50-gal. tank in the right wing gun bay; one 24-gal. tank in the left wing gun bay, and one 20-gal. tank on each side at the outboard ends of the center wing.

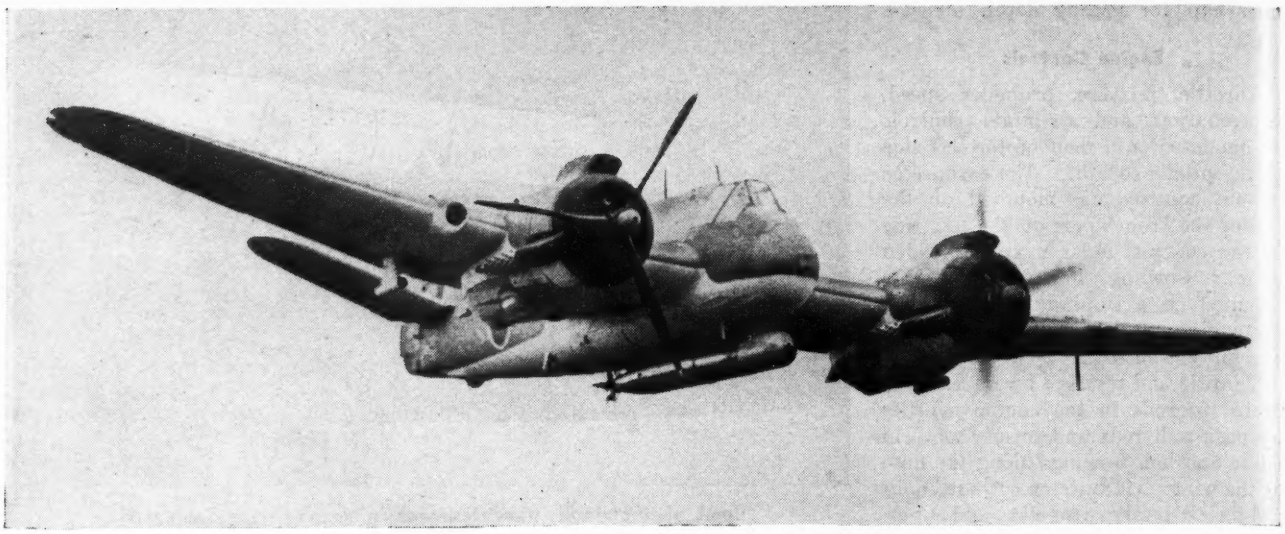
The center wing tank in each wing is connected to the outer series through the 3-way cock in the engine nacelle. The supplementary wing tanks are also connected with the fuel balance pipe in the engine nacelles—through Superflexit hose. They are vented through a common pipe which is carried along the wing to the fuselage and terminates near the fuselage roof on the right side.

Power Unit

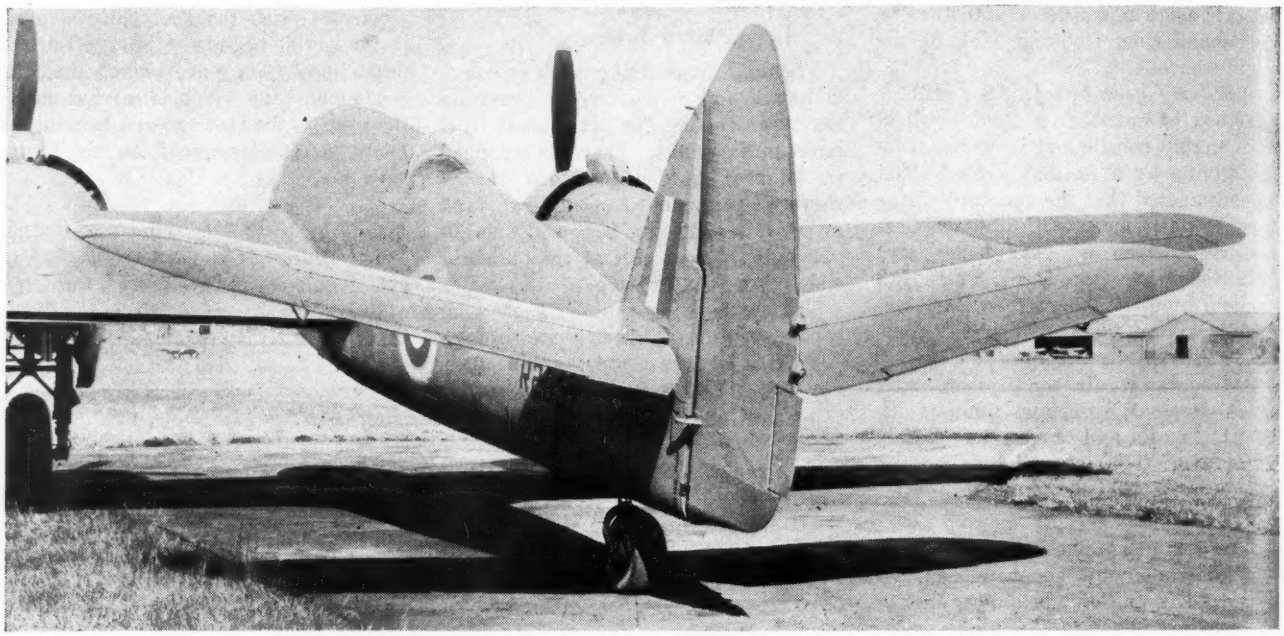
The *Bristol Hercules* engine is a 14-cyl. double-row sleeve-valve type with a total capacity of 2,360 cu.in. (38.7 litres). Bore is 5¾-in. and stroke 6½

Mounting of earlier-type, drum-fed cannon under side of nacelle. Large lagged pipe supplies hot air to gun breech.

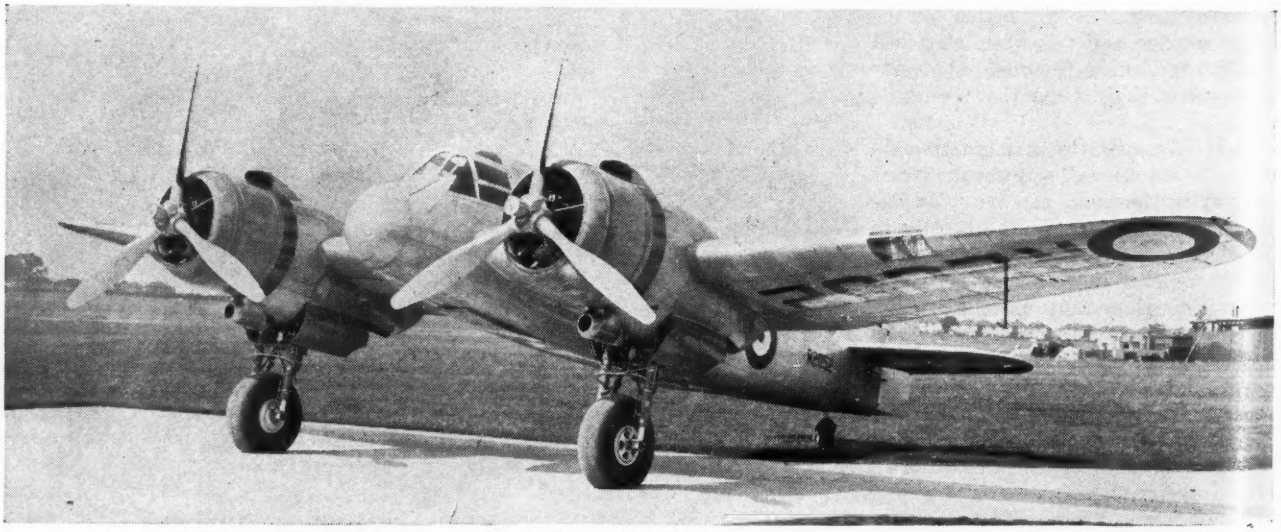




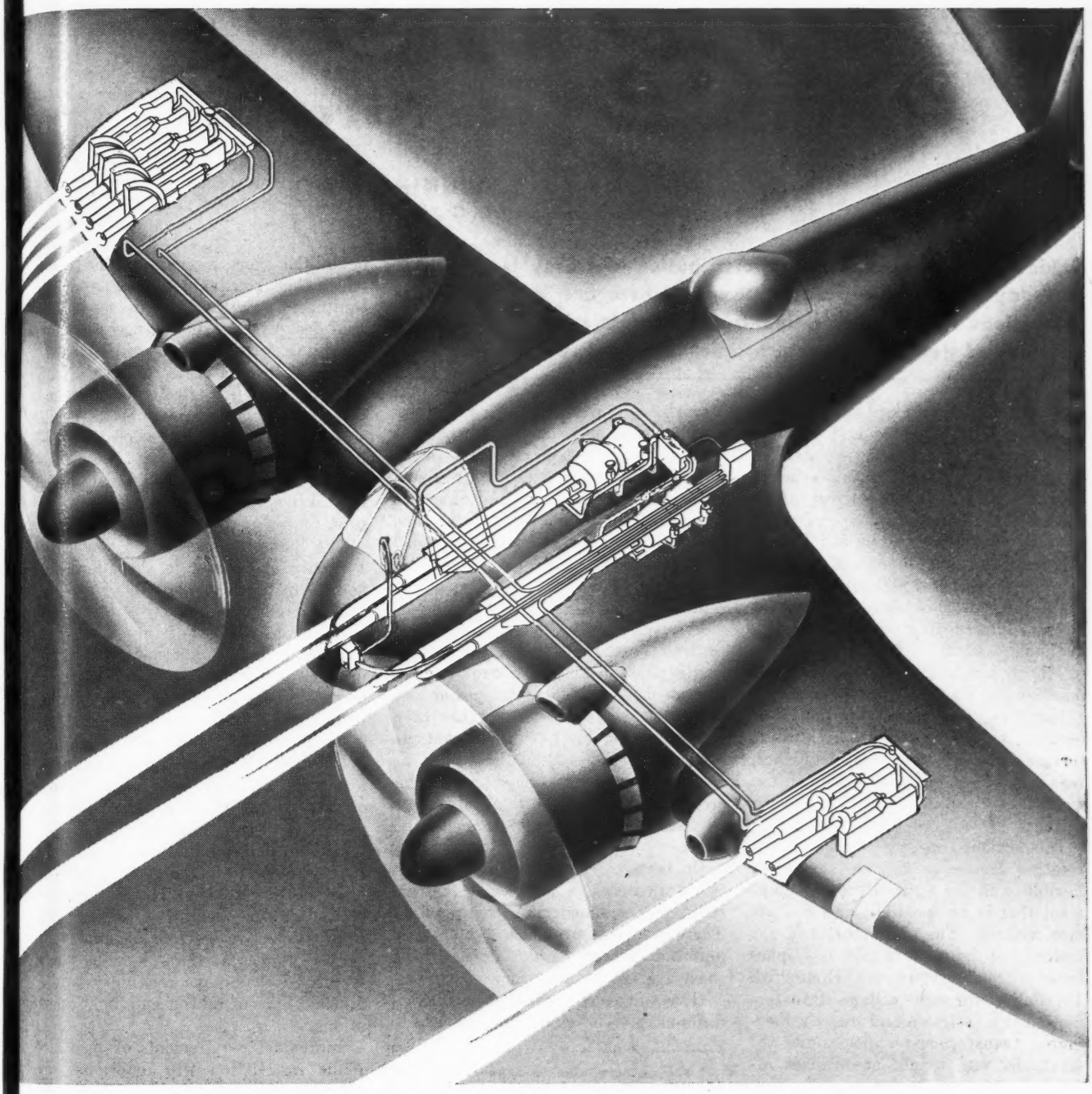
Latest torpedo carrying type *Beaufighter*, with 12 deg. dihedral tail surfaces, flying with one engine stopped and propeller feathed. Note venturi tube beneath wings for brakes.



Later *Beaufighter* type with dihedral tail.



Original *Beaufighter* of 1940 with horizontal tail surfaces.



Firepower diagram of *Beaufighter* showing four 20-mm. cannon beneath pilot, two .303 machine guns in right wing and four of same caliber in left. All are fired selectively by pneumatic control.

in. The latest production series of the *Hercules* fitted in the *Beaufighter* develops over 1,650 bhp. and is fitted with a two-speed supercharger. Other figures are not yet available for publication. Provision is made for constant speed multi-blade propellers for the Hydromatic or electrically controlled type. The engine is mounted as a complete self-contained, cowled, and cooled installation power unit, with flame-damped exhaust system and the engine mounting designed for quick four-point connection to the airframe.

For some time *Beaufighter* has been in quantity production in a number of factories in Great Britain and also in Australia. Only performance information available for publication as yet are that it has a top speed of over 335 mph. Fitted with four cannon and six machine guns, it is still regarded as the most powerfully armed fighter in the world.

Originally designed as a night fighter, this powerfully armed craft brought down more night raiders than the enemy could replace, thus defeated blitzes by night. Once the unlucky raider was caught in the *Beaufighter's* gun sights, a brief burst from cannon and guns, and the enemy disintegrated. But the *Beaufighter* proved such a useful, fast, and reliable aircraft that it was further developed for many other services, including army cooperation work and ground strafing in North Africa and Italy, where its aircooled engines had the advantages of being able to cope with extreme conditions.

It was also developed for Coastal Command, which involved many modifications for long-range patrol work, convoy escort duty, and finally as a torpedo-carrier, for which it is particularly adaptable, being fitted with automatic air brakes for the final run up to the target. Once the torpedo is released, the double flap air brakes close and it once again performs as a normal high-speed long-range fighter.

A.C. *vs.* D.C. In High-Altitude Aircraft

By R. W. GEMMEL and J. C. CUNNINGHAM
*Westinghouse Electric & Mfg. Co.**

Achievement of new electrical-distribution efficiency is a "must" in today's complex warcraft. Discussed here are the latest considerations for insuring reliability, with particular reference to adoption of standard power principles in altitude operation.

DEMAND FOR INCREASED electrical generating capacity and distribution-distance requirements encountered on large aircraft have placed a heavy weight penalty on the electrical installation, if the present practice of using the low voltage d.c. system is followed. Higher d.c. voltages are not yet considered practical for high altitude operation (30,000 ft. or more) because of circuit interrupting difficulties with available control devices and because of short brush life on commutating machines in rarefied atmospheres.

For these reasons, a.c. equipment is used on large aircraft for high altitude service with a voltage of 120 or higher, resulting in a marked reduction in the weight of copper in the distribution system.

In addition, a weight reduction in the rotating apparatus and an increase in flexibility in the application of equipment that is not possible with d.c. are also realized. The alternators and a.c. motors are lighter and take less space because commutators are eliminated. Flexibility through voltage transformation is a desirable feature. Furthermore, transformer-rectifier units of small size and weight are utilized effectively to provide for any d.c. that may be necessary.

Other benefits are gained by the application of a.c. Three-phase induction motors are particularly suited to meet aircraft applications and, therefore, such a system is utilized. Higher motor speeds are practical and result in reduced weight and space requirements. To permit the use of these higher speeds and to realize weights of transformers, frequencies within the range of 300 to 500 cycles per sec. are employed, with 400 cycles per sec. as the present accepted standard.

In most applications, a grounded neutral is desirable and, since certain single phase loads are a requirement, the conventional 208 v. line-to-line and 120 v. line-to-neutral system has been generally adopted. Even higher voltage systems will be used in the future, as electrical loads and airplane sizes increase, to continue to take advantage of weight reductions in equipment and wiring.

On large aircraft, the electrical system approaches in complexity that encountered in industrial power practice. Therefore, the problems encountered and the systems employed in solving them are not entirely new.

However, there are some fundamental differences. The chief ones appear to be in the short mechanical and electrical time constants of the rotating equipment (aircraft designs vs. industrial designs) and in the necessity for providing satisfactory operating characteristics over a wide range of fault currents. Even neglecting fault impedance, this range may be as much as 101 to 11 at any given location, depending on the type of fault, the generating capacity that is available for service, and the ambient temperature.

The industrial method of providing a reactor or resistor in the alternator neutral in order to limit this range of fault current is not effective in aircraft applications because of the practice of grounding the motor neutrals. This practice is desirable to obtain starting torque in the event that one of the three phases to the motors has failed, thereby providing additional reliability to the over-all system. Some running torque is available even with failure of two of the three phases with the grounded neutral scheme.

Use of current limiters to provide short-circuit protection is described later in this paper. The importance placed on the weight of wiring and fault protective devices demand that careful studies of the system be made to insure maximum reliability under all conditions of takeoff and flight operations.

Individual requirements of each airplane installation will determine the distribution system which should be used to attain the necessary reliability

* The authors wish to acknowledge contributions by the Army Air Forces and aircraft companies to the work detailed in this article.

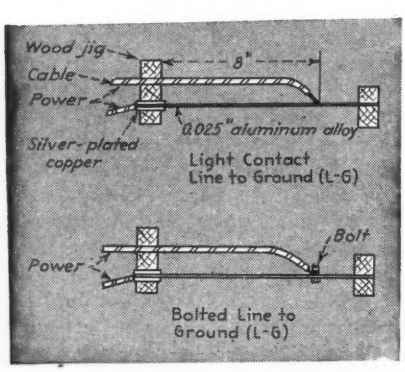


Fig. 1. High and low thermal capacity 400-cycle line-to-ground fault tests.

TABLE I—RESULTS OF L/G TESTS.

Wire Size AWG	Press. Alt. Ft.	Volts Open Circ.	Volts Max. pk. Recov.	Amp.* Max. Init. Avail.	Amp.* Max. Fault	Amp.* RMS Fault	Total time Sec.** Conduct	Total time Sec.** Clear	Number of Restrikes
				A — Light Contact					
20	1,000	120	170	1,800	1,000	900	.007	.024	1
20	40,000	120	170	1,800	1,020	950	.007	.052	2
14	1,000	120	170	1,800	1,420	1,150	.026	.082	3
14	40,000	120	170	1,800	1,460	1,260	.032	.115	3
8	1,000	120	184	2,100	1,850	1,550	.152	.232	10
8	40,000	120	230	2,100	1,800	1,650	.199	.211	1
				B — Bolted Contact					
20	1,000	120	170	2,100	1,530	1,190	.025	.025	0
20	40,000	120	170	2,100	1,570	1,260	.018	.018	0
14	1,000	120	200	1,800	1,590	1,480	.265	.265	0
14	40,000	120	170	1,800	1,590	1,480	.270	.270	0
8	1,000	120	170	2,100	2,050	1,900	3.3	3.3	0
8	40,000	120	170	2,100	2,050	1,900	3.8	3.8	0

Notes: * All values are symmetrical rms amperes.
Maximum initial available amperes is the maximum initial current obtainable from the circuit for a solid fault.
Maximum fault amperes is the maximum rms current that occurs during the fault period.
RMS fault amperes is an approximate rms value for the total.
** *Total clearing time* includes all conducting and nonconducting periods between fault initiation and final clearing.

with minimum weight. Factors affecting this study and evaluation are location of alternators, location and sizes of loads, and whether provision must be made for isolated operation of the alternators. Many combinations are possible and should be studied to take full advantage of weight reduction without impairing reliability.

In all applications, multiple circuits are used to add reliability within allowable weight and voltage regulation limits. Use of the a.c. network calculator provides a means of quickly checking any proposed system or circuit to determine accurately load distribution, voltage regulation, and short circuit conditions of any proposed installation.

The required characteristics for an acceptable aircraft electrical distribution system in the order of their importance are:

1. Reliability, 2. light weight, 3. simplicity, and 4. low maintenance.

Of these, the first two are essential while the third and fourth characteristics are highly desirable. Any proposed system must be able to deliver the current required under all reasonable operating conditions at a voltage which will permit motors to operate efficiently and develop adequate starting torque. Provision must be made for satisfactory operation in spite of the failure of apparatus and cable circuits during flight. Considerable judgment is required to determine just how many such failures constitute "reasonable operating conditions," especially when it comes to predicting damage by gunfire. There must be a compromise, in the degree of reliability established as a goal, in order that weight penalties do not become too great a burden.

A simple distribution scheme is desirable in order that the crew can more readily understand the over-all operation of the electrical system from the point of generation of power to its ultimate utilization. Minor troubles encountered in flight can be corrected only if they can be quickly diagnosed and readily located. Simplicity also facilitates production and reduces installation costs to a minimum.

Low maintenance is also desirable to increase available flying hours to a maximum. General overhaul and repair time can be materially reduced if proper consideration is given to the distribution system layout in the airplane. Protective devices, which periodically must be checked or replaced, should be readily accessible. Load distribution buses and other important power centers should be adequately protected to prevent damage that would require major repairs.

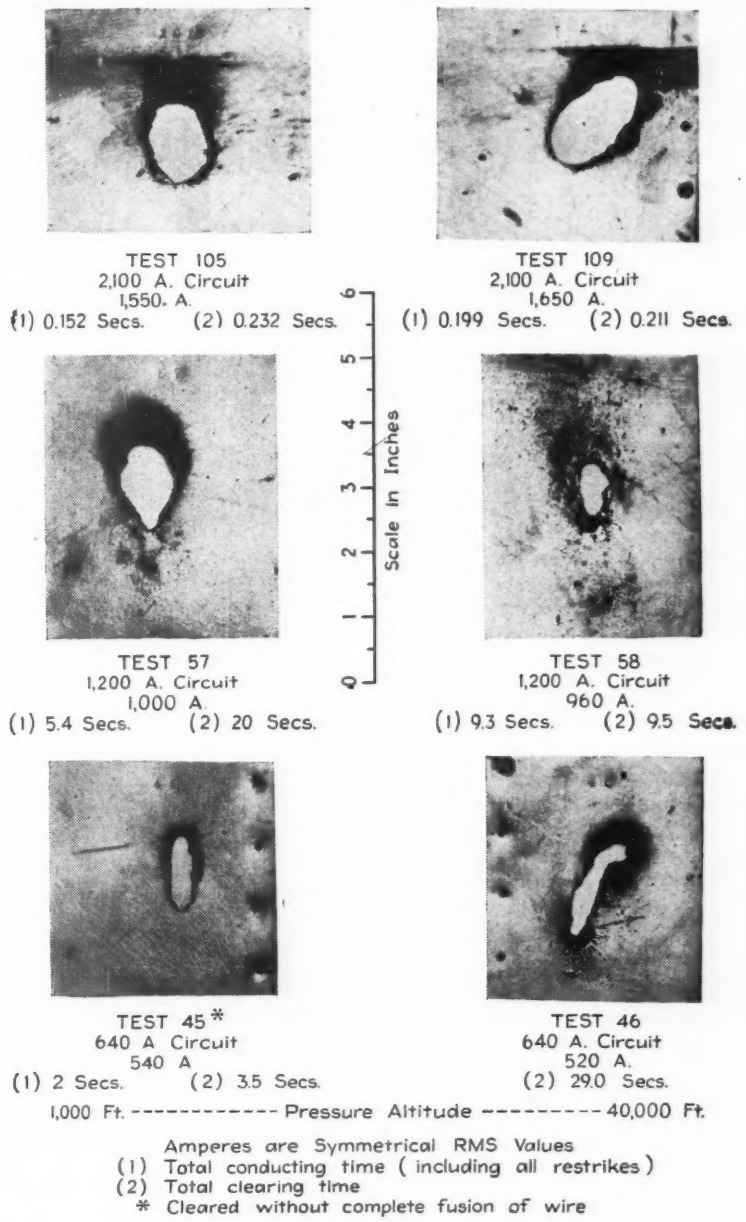


Fig. 2. Aluminum fuselage samples showing damage by line-to-ground light-contact faults.

Furthermore, in the design of a distribution system it is essential that the number of protective devises specified and the different ratings selected be kept to a minimum consistent with the degree of reliability necessary. Theoretically, added protection can generally be obtained by using more devices, by increasing the number of different ratings that are applied, or by doing both. Practically, however, the real benefits will be entirely lost due to difficulties in maintenance and in availability of replacement supplies.

Much time could be saved in studying the distribution system possibilities for any given airplane if the nature of the faults most likely to occur, and the approximate number that might be experienced under normal or abnormal conditions of operation, were known. Unfortunately, statistical data and operating experience are lacking in this respect. Verbal reports indicate surprisingly few electrical faults in the wiring resulting from combat, most of them consisting of open circuits.

The majority of faults that occur apparently are apparatus failures resulting from vibration, overload, or inadequate design. There have been a few cases where damage to the electrical system has caused complete electrical failure or a serious fire. There have

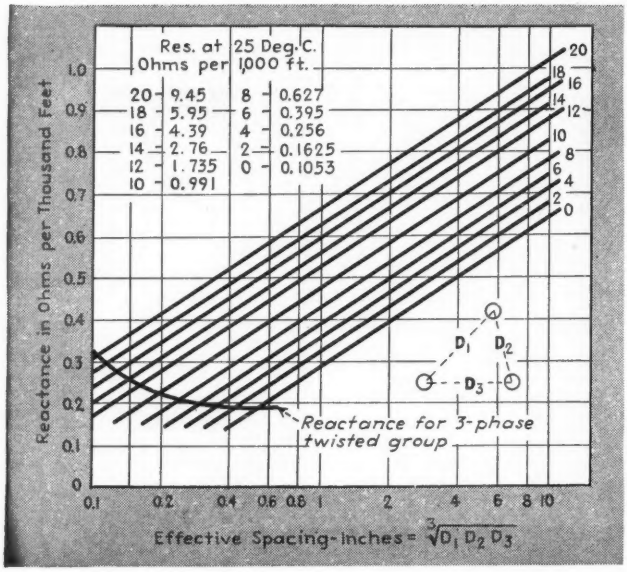


Fig. 3. Resistance and reactance of typical aircraft cables at 400 cycles per phase in 3-phase circuit.

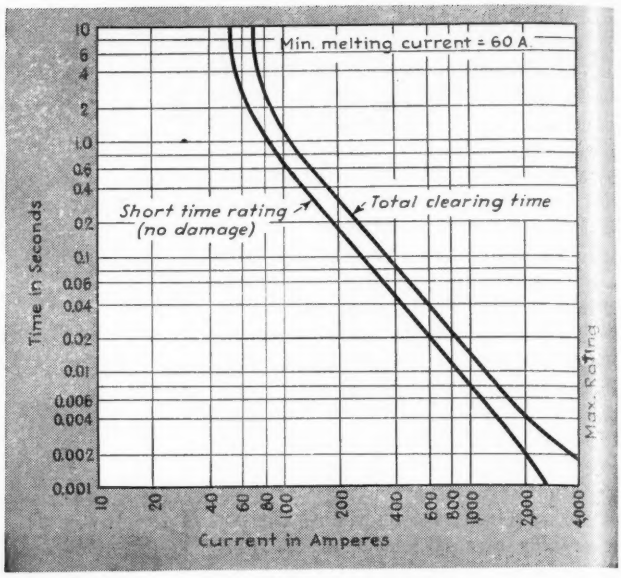


Fig. 5. Typical characteristics of aircraft limiters starting at 25 deg. C. with no initial load.

also been short circuit failures during attempts to make repairs when in flight with power on the system. All experience or data available is based on the low voltage system (28.5 v. d.c.) which, because storage batteries are employed, has fairly high short circuit current values under conditions of minimum generation. However, even under these favorable conditions of high current and low voltage, faults are not always self-clearing.

Laboratory tests, simulating high altitude conditions, have been made to determine burn-clear characteristics of the 28.5 v. d.c. system, and results check closely with the meager reports of field experience. Self-clearing action can generally be depended on, but it is a function of the wire size, type of short circuit (light or heavy contact), and current available at the fault.

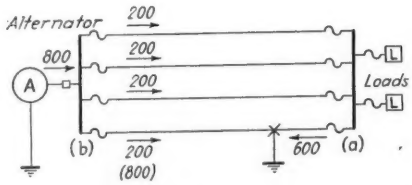


Fig. 4. Current distribution in 4-circuit feeder during 800 amp. ground fault.

Little data has been available on fault characteristics for the 400-cycle electrical system at voltages above 150 v. and under high altitude conditions. To determine whether self-clearing action could be expected, a series of tests were made over a range of 120 to 440 v., 60 to 2,100 amp., and sea level to 40,000 ft. A vacuum chamber was used to represent high altitude conditions. Faults of both high and low thermal capacity were simulated for line-to-line and line-to-ground short circuit conditions using No. 8, 14, and 20 aircraft wire (see Fig. 1).

Table I shows, at (A), the results of typical low thermal capacity line-to-ground tests. The shots were alternately at low and high pressure altitudes for the wire sizes mentioned. Tests of this type were made to simulate a light-contact short circuit between the wiring and the metal structure of the plane. The majority of faults will probably be of this nature.

Tests indicate that a very high percentage of such faults will be self-clearing at these voltages when the fault current is sufficiently high. Value of current at which the fault will not clear without serious physical damage and fire hazard is a function of wire size.

At (B) in Table I are results of high thermal capacity line-to-ground faults under the same conditions as used for the line-to-ground tests. Faults of this nature are not likely to occur frequently, but they cover the worst condition possible because of the increased thermal capacity.

With high thermal capacity faults

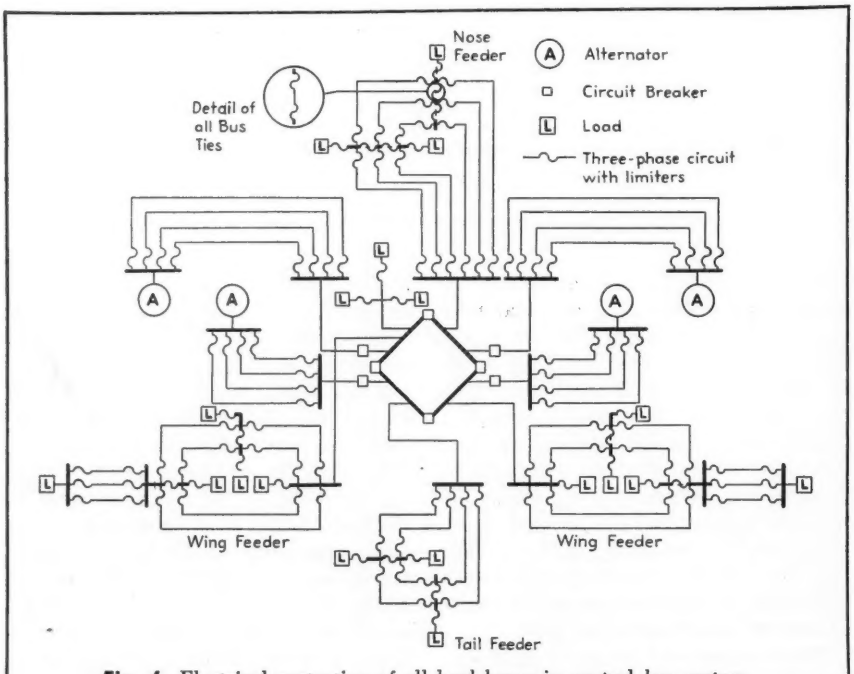


Fig. 6. Electrical protection of all load buses in central bus system.

there was appreciable damage to No. 14 and 20 wire below 1,000 amp. The insulation of No. 20 wire blistered at 600 amp. At this current value, No. 14 wire samples cleared slowly and in most cases burst into flames. High thermal capacity faults on No. 8 wire resulted in damage to the insulation at current values below 1,600 amp.

Table I gives us a tabulation of test results of both low and high thermal capacity line-to-ground faults. It will be noticed that a change in altitude conditions has no appreciable effect on the clearing time of the faults irrespective of wire sizes. All faults will have satisfactory burn-clear characteristics under normal or altitude conditions only if sufficient short circuit current for a given wire size is available.

Fig. 2 shows photographs of typical tests of No. 8 wire under line-to-ground faults (120 v.) with three different values of current at both normal and high altitude pressure (40,000 ft.).

From the evidence available it appears necessary that in any distribution system, at least for military aircraft, sectionalizing devices be provided to clear at least one fault in any load area without loss of load. Ability to clear a second or third fault in the same area is desirable but is not justified at the expense of a large weight increase. A fault on a load bus will, of necessity, cause the loss of some load, but it should not be permitted to cause the loss of loads on other buses.

Since no field experience under combat conditions has been obtained with the a.c. systems of the types under consideration, the laboratory test results must be used as a guide until operating data becomes available. However, the similarity between laboratory results and flight experience on the low voltage d.c. system indicates that the a.c. fault tests are a reasonably accurate representation of flight conditions.

An important consideration in the a.c. system design is to provide sufficiently fast fault clearing to prevent motor stalling and insure maintenance of alternator synchronism. In a typical system, faults must be cleared in approximately 0.1 sec. to prevent motor stalling. This time corresponds to minimum generating capacity equal to the connected motor load. At this time, however, there is insufficient data available on the alternator drive characteristics to state any criterion for maintaining synchronism.

The wire size and the continuous rating of interrupting devices depends on the number of faults which must be considered and the permissible wire temperatures. This requires judgment of the relative value placed on extreme reliability and on minimum weight. The following design conditions are representative of present opinions and should not necessarily be considered as a final criterion.

In choosing wire sizes and the ratings of protective devices, provision should be made to carry normal loads at normal temperatures with one prior fault in any feeder. After a second fault, it should be possible to handle normal loads and motor acceleration duty at temperatures below those causing wire failures or protective device tripping.

Abnormal loads caused by stalled motor conditions which follow jamming of turrets, wing flaps, and other similar applications, should not cause serious wire damage or tripping after one prior fault.

Until more is learned about the operating characteristics of constant-speed drives, provision for isolated alternator operation must be included in the selected distribution system. Furthermore, the ability to parallel alternators successfully depends on the time constants of the drives, of their governor, and of the alternators as well. Further laboratory tests and operations under actual service flight conditions will be required before dependable paralleling can be relied on.

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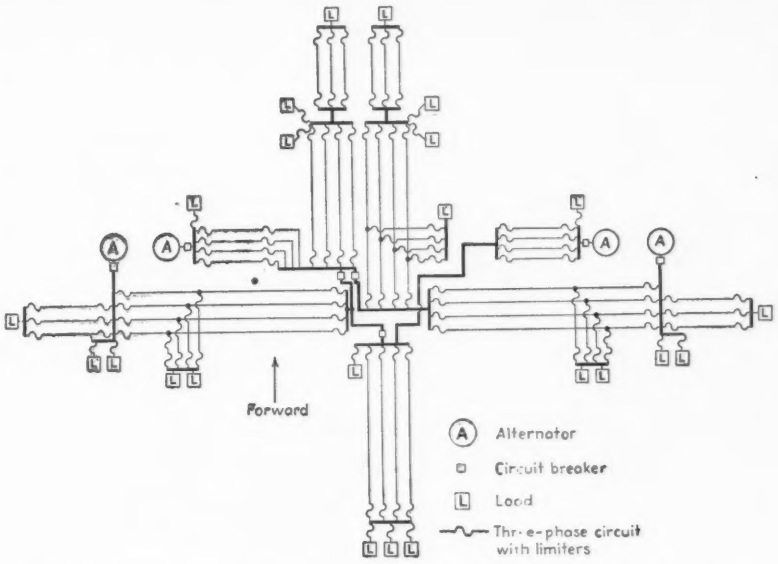


Fig. 7. Central bus system—electrical and mechanical load bus protection.

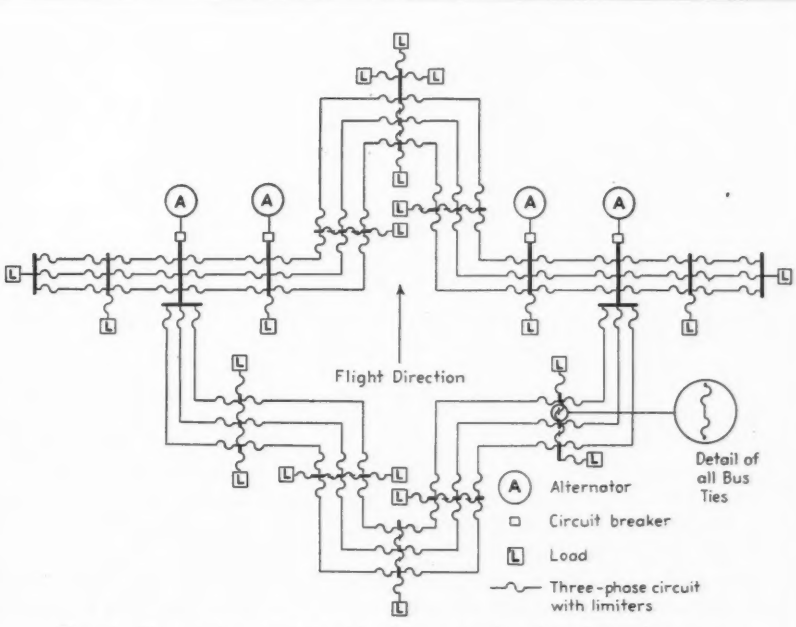
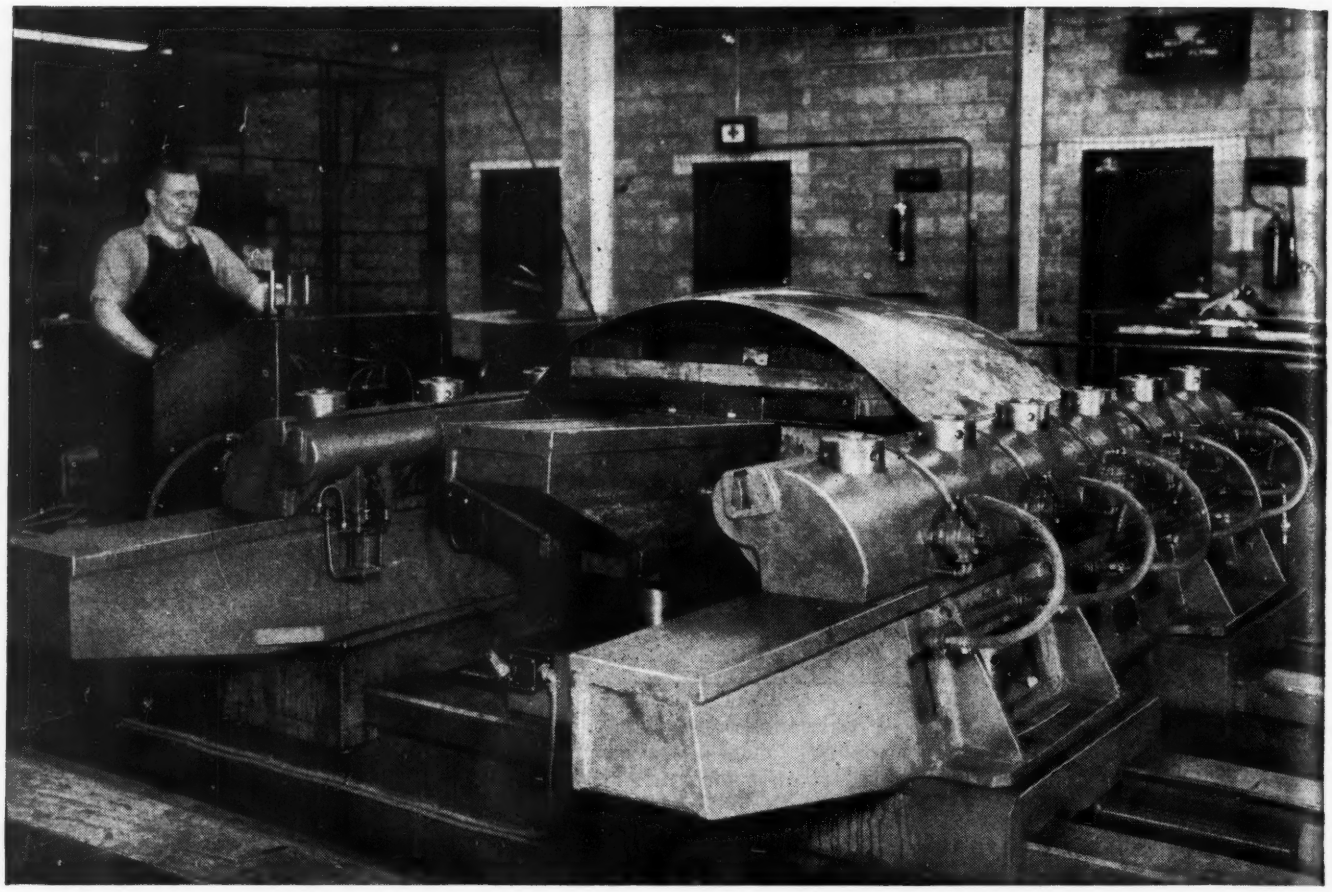


Fig. 8. Electrical protection of load buses in distributed ring bus system.



Aluminum alloy being formed on Masonite die.

Masonite Dies Do A-1 Job

In what was first regarded as only a temporary emergency material, Grumman discovered a practical die stock which is lighter, more speedily worked, and more economical than steel.

TO get into increased production on *Avengers* and *Wildcats,* engineers at the Grumman Aircraft plant turned to immediate fabrication and construction of 19 new jigs on which to assemble tail sections. Large plate sections used on these jigs required eight days each to fabricate in steel, a time element threatening to slow down completion of the schedule.

Then the engineers tried redesigning the section, making use of semi-plastic Masonite die stock in place of steel. Four days later all parts were ready for the erection of the 19 jigs. This incident, illustrative of a new development in industrial fabrication, is another example of American ingenuity and inventive skill in finding a "better way."

Robert M. Boehm, Grumman's director of research, is responsible for much of the development of Masonite die stock.

The properties of this new die stock which have recommended it are its lightness (one-sixth the weight of steel), the speed with which it can be worked (ten times faster than steel), its basic cost (one-fourth that of steel); and the fact that it frees appreciable amounts of vital metal for other important uses.

The story of Masonite semi-plastic die stock began 20 yr. ago when the late William H. Mason began experiments to produce a ligno-cellulose hardboard of controlled plasticity from the thousands of tons of wood chips and lumber ends that were customarily consigned to huge trash burners, being considered at that time unusable by-products.

These chips were exploded in a steel "gun" under steam pressure, the resulting mass of wood fiber subjected to hydraulic pressure and heat to produce a board whose principle properties were density, hardness, and strength—imparted to it because wood's natural binder, lignin, and the cellulose fibers remained undamaged but rearranged in the finished product.

Following this early beginning, experiments were carried on looking toward the development of plastic material from a wood base. One of the results of this work was a die stock, in thickness ranging from $\frac{1}{4}$ in. to 2 in., readily adaptable to the construction of deep draw dies, jigs, router forms, and assembly fixtures. The use of the new product was expedited by the patented process developed by Henry E. Guerin.

This process provides for the easy adaptation of hydraulic and toggle presses to shear or form thin gages of metal with one operation through the use of restrained rubber pads and form blocks of Masonite die stock. This technique eliminates need of mating dies.

Grumman was one of the first aircraft companies to speed production through the use of dies which are quickly fabricated with ordinary high

speed woodworking tools. Company production engineers first made such dies to form many of the light metal parts for the F3F, the Navy fighter of 1937, using this material primarily because the size of the production then required did not warrant the expense of costly metal dies.

As production runs increased with the start of the war, the company continued to employ die stock in larger quantities to keep plane production ahead of schedule.

Today, Grumman uses Masonite die stock for router forms, shear dies, form blocks, spinning chucks, templates, stretcher forms, assembly jigs, and fixtures. Principle advantage is the speed with which such dies can be fabricated, using either high speed wood or metal working tools.

In fabricating deep draw dies, a layer-by-layer dry mock-up is first made. This is demounted, glued with weldwood, a glue with urea formaldehyde base, and then screwed together, layer by layer, to provide additional strength. Production is speeded by making only one die to stamp out similar left and right parts in one operation. The stamping is cut in half for final installation.

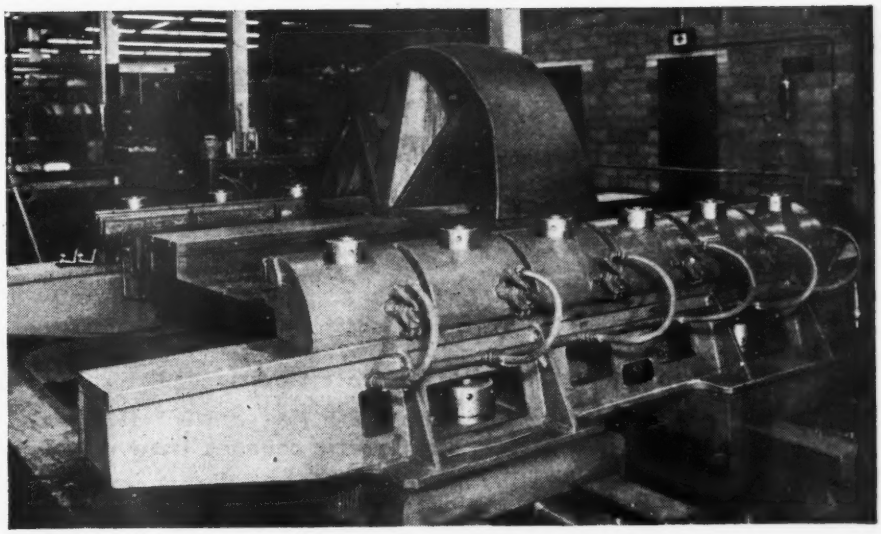
Router forms of die stock are used for such parts as instrument panels, where the holes to receive the instruments are extremely close together, and in trimming nose rib stampings having a variety of irregular shaped cut-outs and edge contours. Blanks for wing skins, of a size and gage for which dies cannot be easily supplied, are subjected to the router method for forming speed.

Use of Steel Facing

Deep draw dies are made with an addition of a surface plate of ¼ in. chrome-moly steel for forming and drawing such intricate and deep shapes as auxiliary gas tanks, wheel house fairings, cowling rings, and fire baffles. Smaller dies of less thickness, also faced with chrome-moly steel, are used for form and shear wing ribs, and trailing and leading edges of wings.

Large parts of the skin sections of *Avengers* and *Wildcats* are formed on stretcher forms of die stock. The sheet of metal to be formed is first chilled, then securely locked with hydraulically operated clamps in position over the die. Hydraulic pressure is applied to the bucking ram, which activates the die to form and stretch the skin sections to exact size and shape.

Spinning chucks of die stock are also fabricated easily and quickly. Chucks of this material have an extra advantage, since the metal does not freeze to them while being processed. Engine ring cowlings, already partially completed on deep draw dies, are further processed on spinning chucks to shape them correctly for final installation, saving several hours over any other processing method yet found.



Die used for forming section of *Wildcat* fuselage.

In addition to the tail assembly jigs already described, the company employs hundreds of other jigs and assembly fixtures for installing temporary fastenings to hold fuselage skin sections together until riveting is done. Die stock jigs free steel for use elsewhere, and they are so light that they can be easily moved by women workers.

Dies and other equipment fabricated from die stock have a long and trouble-free production life. Denseness of the material makes it suitable for use in all climates, as moisture absorption and consequent contraction and expansion of dies is so small as to be entirely negligible in the finished products. The lightness of the material provides for easy installation and saves time on the assembly and production lines.

Deep-draw die shaping auxiliary tank ends.

Pertinent Problems In Electric Control Design

By F. W. HOTTENROTH,
Industrial Control Engineering Div., General Electric Co.

Constantly facing designers of aircraft electric controls are the prime questions of vibration (how curb it?), weight (how lower it?), size (how cut it?), and atmospheric changes (how accommodate for them?). Moreover, the formula for a suitable control must tackle all four factors at once.

POWER IS USEFUL only when it is controlled, and since an increasing amount of electric power is being used on airplanes, many forms of controls are required to employ this power properly.

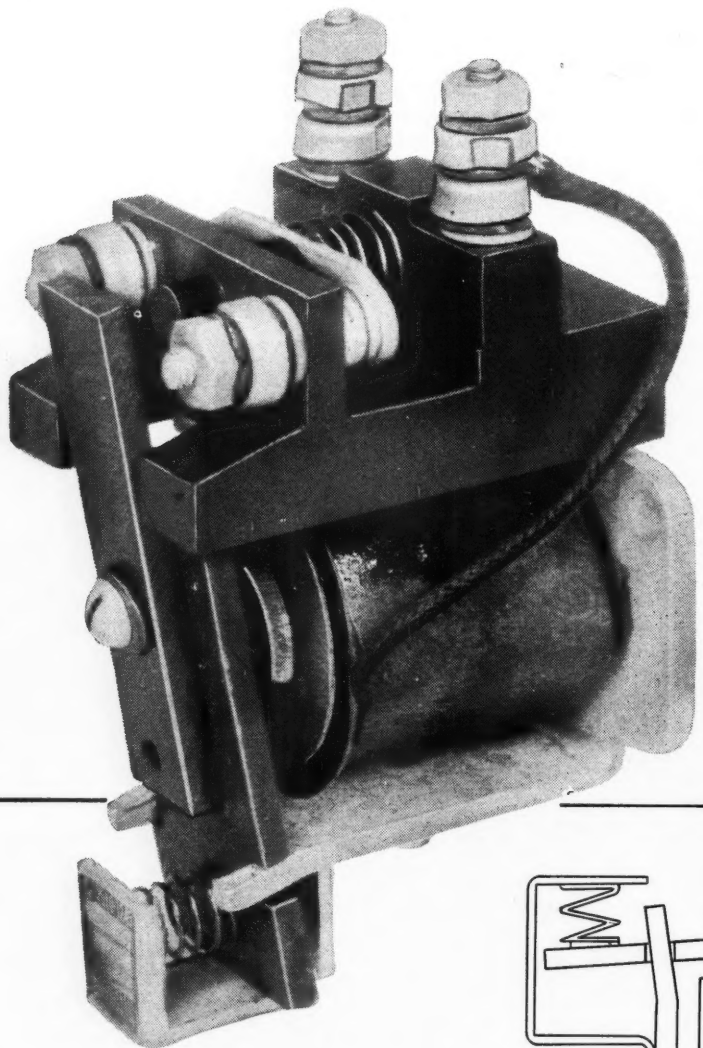
For instance controls in the form of contactors are used to stop electric motors. . . . Pressure controls operate warning signals to indicate incorrect pressures and to control motors to maintain correct pressures. . . . Thermostats and temperature control systems maintain correct temperatures for best operating conditions, or signal incorrect temperatures which might cause trouble. . . Timing devices control signal lights, bomb releases, and sequencing operations. . . . Small relays act as triggers to control and direct large amounts of electric energy.

Most of the forms of devices required on airplanes for the control of electric power are listed below. These devices are linked together to form systems for the control of temperature, pressure, position, synchronizing, and for motor controls.

Relays—Sensitivities as low as ½ milliwatt, and contact structures having 26-pole double throw.

Contactors—Ratings to 200 amp. Dynamic braking motor controls. Reversing contactors.

Timers—Timing values from a fraction of a second to a two-minute cycle.



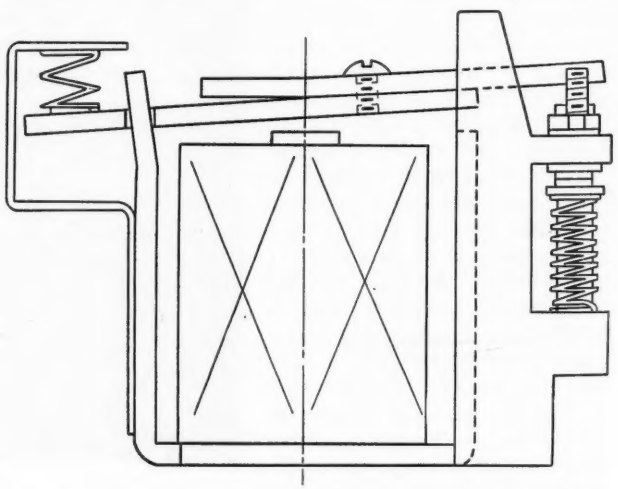
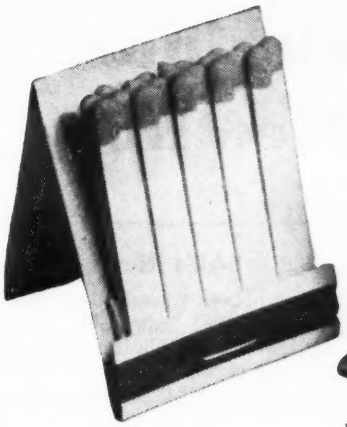
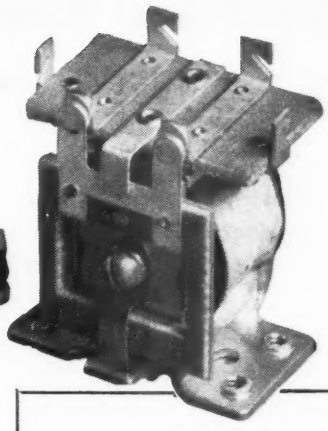


Fig 1 (above). Common industrial type relay with unbalanced armature. Pivot is ordinarily placed at extreme end of armature. Entire construction is extremely sensitive to vibration. **Fig. 1a** (right). Sketch of unbalanced armature.





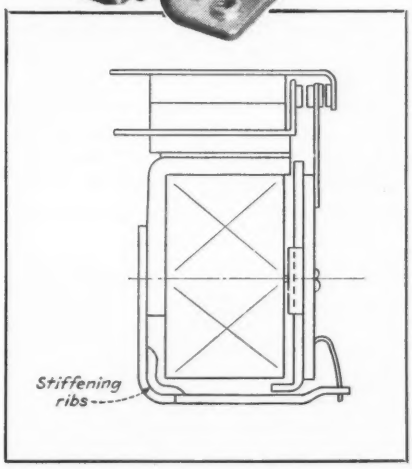


Fig. 2. (above). Typical aircraft relay with balanced armature construction basically unaffected by vibration. Contacts are rated 20 amp. at 24 v. d.c. Photo gives size comparison with book of matches. **Fig. 2a** (right). Sketch showing stiffening ribs which prevent relative movement of parts by vibration.

Switches—Control switches, limit switches, cam selector switches, 20-pole double throw switches.

Thermostats—From 0 deg. F. operation to 1,000 deg. F operation.

Pressure Controls—From 1-in. water pressure to 3,000 psi.

In performing these functions on planes, the electric controls are fundamentally the same as the controls which have been used for many years for similar functions in industry and in the home. But even when the function is identical, the difference in conditions encountered on planes has made it necessary that the design of controls specifically for aircraft should be functional—particularly suited to the conditions encountered on the planes.

Of course, a few controls which were originally designed for other purposes have been adopted for aircraft, but the best results are obtained by new designs, custom-built to meet conditions aboard aircraft.

The devices used on planes must operate properly under severe conditions of vibration and acceleration. They must remain undamaged after being subjected, for long periods of time, to extremes of temperature and humidity. Contact ratings must take into consideration the special effects of the low atmospheric pressures encountered at high altitudes. Design safety factors must be high, since the operation of the plane may depend directly upon the operation of the control. But at the same time, it is essential that the devices should be smaller and lighter in weight than previously considered practical.

Vibration and Impact

A number of tests are being conducted to determine the actual vibration and acceleration values encountered on planes. These tests are incomplete and have not been summarized, but assumed values based on field experience have been used successfully as tentative standards.

Experience now indicates that if a device is not damaged by a vibration of $\frac{1}{16}$-in. full travel at frequencies varying from 0 to 3,600 cycles per minute for a period of 10 hr., it will not be damaged by the operating conditions aboard a plane. Furthermore, if the device operates satisfactorily under conditions where the vibration has an amplitude of $\frac{1}{32}$-in. full travel at frequencies from 0 to 3,600 cycles per minute, it will operate satisfactorily under the vibration encountered on a plane.

In order to make controls suitable for such vibration, the general problem can be studied on the basis of simple design fundamentals. Most controls have pivoted members. Relays, thermostats, pressure switches, and similar devices, all have members which are pivoted in order to produce their desired functions. Figs. 1 and 1a show the common type of relay used on industrial control devices. The pivot is ordinarily placed at the extreme end of the armature. This type of construction is extremely sensitive to vibration.

On the other hand, Figs. 2 and 2a show an equivalent relay designed for aircraft. This design has a balanced armature construction and is basically unaffected by vibration. It is advisable to use this type of construction whenever vibration conditions are encountered, and it should be noted that accurate balancing of moving parts is most essential when only small forces are

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This 10 amp. snap-action switchette is one of smallest electrical devices for aircraft use. It weighs $\frac{1}{8}$ oz. and is but one-third weight of similar devices for non-aircraft use.

Postwar Aviation Techniques Spotlighted in SAE Meeting

Outstanding papers reflect high clarity in industry's "approach to future." . . . . Engineering, design, production, and maintenance factors get detailed consideration, and new peacetime aircraft market is ranged . . . . James, of Studebaker, named '44 president.

COMPREHENSIVE STUDIES of current aviation technical factors, with particular reference to their bearing upon the industry's program for the coming peace, marked the alert sessions which comprised the Society of Automotive Engineers' 5-day annual meeting in Detroit in January. The gathering attracted more than 2,500 members representing both the aircraft and automotive fields.

Tabulation of the topics quickly indicates the great breadth covered by the papers. Initially, there was consideration of the many advances in the aircooled aircraft engine sphere—advances which point to automotive application of the new principles. There followed a thorough-going talk dealing with Canadian production of the noted *Mosquito* bomber. Then, in turn, speakers dealt with details of—

The postwar light plane, postwar aircraft markets, airplane engine installation factors, aircraft stress factors, inlet and exhaust porting, low-cost cylinder design, cylinder wear, aircraft engine cooling factors, use of synthetic rubbers, flight problems with engines, ground development testing, service life of machine parts, selection of cutting oils, time- and material-saving production methods, and lighter-than-air craft in the cargo field.

Each of these talks is reviewed in the following columns.

The paper Aircooled Engines for Automotive Vehicles was delivered by Chester S. Ricker, Detroit Editor of AVIATION, who outlined the tremendous strides made by the aircooled aircraft engine builders during the past decade. Application of these principles and experience of aircraft engine aircooling to automotive vehicle engines was shown and the conclusion drawn that if the price of post-war aluminum is as low as some foundrymen expect that successful aircooled engines can be built

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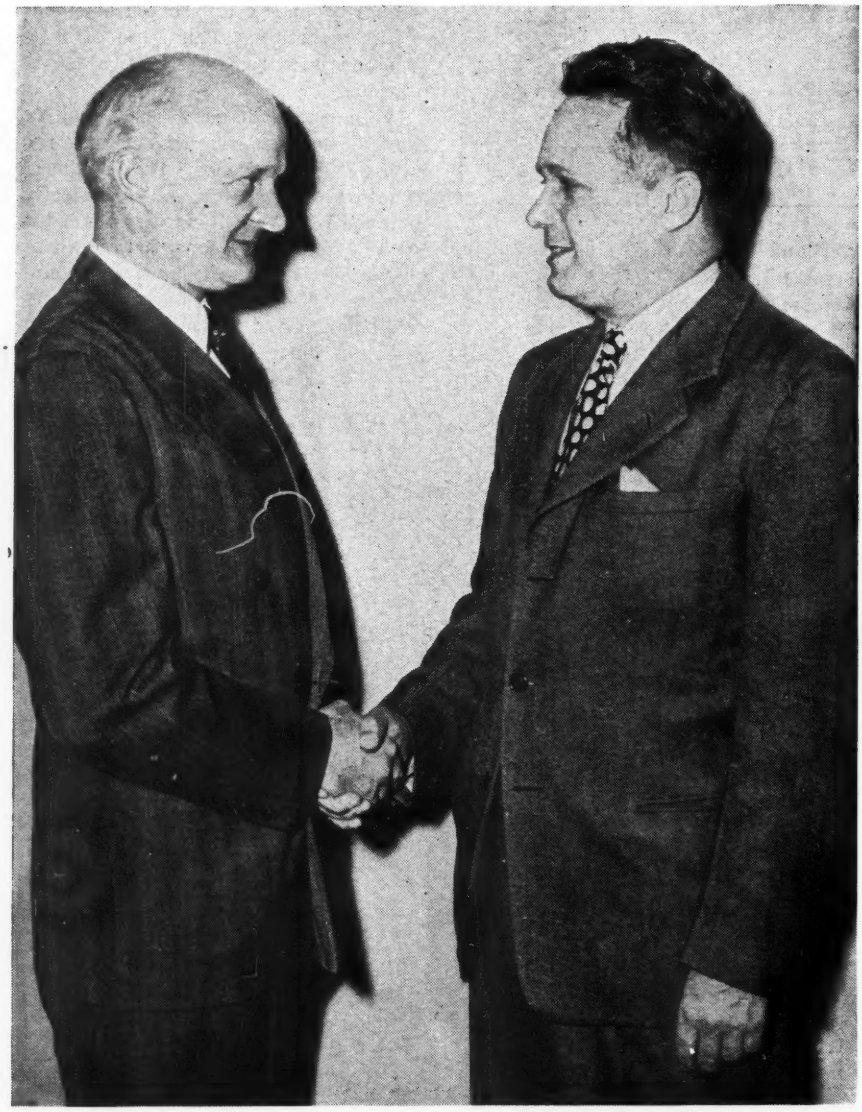

Incoming SAE President William S. James (left) shakes hands with Mac Short, the Society's retiring leader. Former is chief engineer of Studebaker Corp., while latter is vice-president of Lockheed Aircraft Corp.

SAE's New Officers

• ELECTION OF SOCIETY EXECUTIVES for 1944 saw the presidential gavel go to William S. James, chief engineer of the Studebaker Corp. He succeeds 1943 President Mac Short, vice-president of Lockheed Aircraft Corp.

New vice-presidents, representing various activities, include the following:

Aircraft—R. D. Kelly, United Air Lines Transport Corp.

Aircraft Engines—A. T. Gregory, chief engineer, Ranger Aircraft Engine Div., Fairchild Engine & Airplane Corp.

Diesel Engines—A. J. Blackwood, Standard Oil Development Co.

Fuels & Lubricants—J. R. Sabina, E. I. duPont de Nemours & Co.

In addition, Arthur Nutt, chief engineer of Wright Aeronautical Corp., was named a member of the Council to fill the unexpired term of J. C. Zeder, resigned.

X-Rays Now Gage Propeller Blade Thicknesses

By H. P. MOYER, *American Propeller Corp.*

Affording close tolerances, this means of measurement replaces unsatisfactory sectioning and caliper methods. Moreover, new thickness-check procedure is applicable in processing of any ferrous products.

IN THE MANUFACTURE of hollow steel propeller blades, it is of primary importance that the thickness of the metal plate be held to very close tolerances, particularly because strength of the entire blade is dependent upon the strength of a blade cross section composed of leading and trailing edges, thrust plates, and camber plates.

The thinnest section occurs in many designs at the center of the thrust and camber plates, therefore, it is a decided advantage to be able, at any time, to demonstrate the thickness of any particular area.

Previous to the development of the present technique of measurement by X-rays, the only method of determining the plate thickness of 75 percent of the area of a finished blade was by means of the "destructive" method, namely sectioning the blade.

In the manufacture of blades by American Propellers' method, steel tubing is worked by both hot and cold processes to produce the finished article. While the blade is in the tubular form, measurements of plate thicknesses can be accomplished by mechanical means. The bulk of the machining operations are performed while the blade is in the tubular form, thus permitting accurate measurement and control of metal thicknesses.

However, once the blade is in airfoil shape, mechanical measurement of plate thicknesses becomes decidedly limited in accuracy due to the shape of the object. The plates can be measured only by means of entering one prong of a deep throated caliper through the open shank and placing the other on the outside of the blade. Deflections become greater and accuracy less as the distance from the shank is increased, until at the outboard stations mechanical determination of plate thickness becomes extremely difficult.

To provide a suitable solution to the problem, attention was directed to X-ray analysis. Here is the basic premise upon which the work was undertaken:

A given source of X-radiation of suitable wave length will, under controlled conditions, penetrate the plate with a certain intensity, this being a definite function of the plate thickness involved. Further, if the intensity of X-ray penetration of plate of known thickness be studied, the results can

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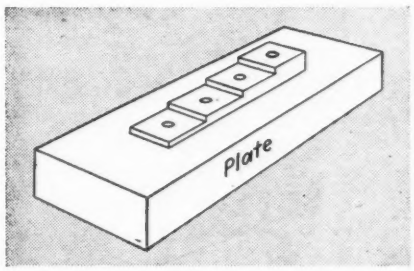


Fig. 1. Stepped test block for determining densities by comparison.

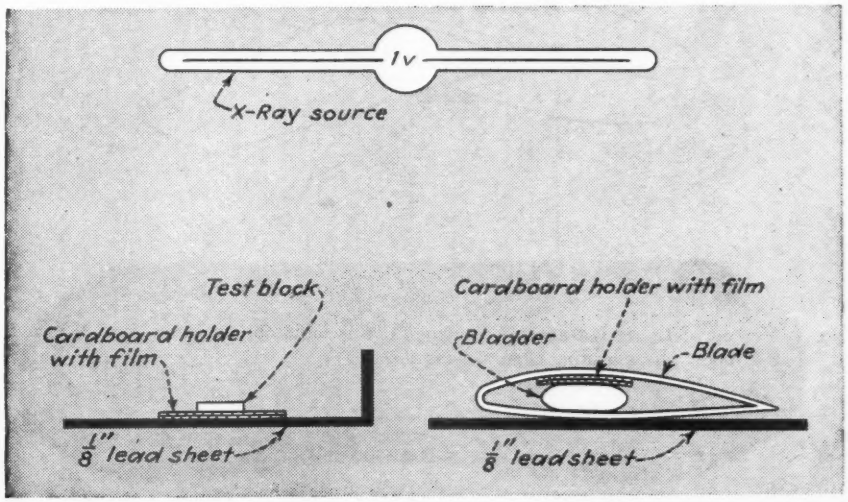


Fig. 2. Methods used in applying film to metal, with or without simultaneous test block application.

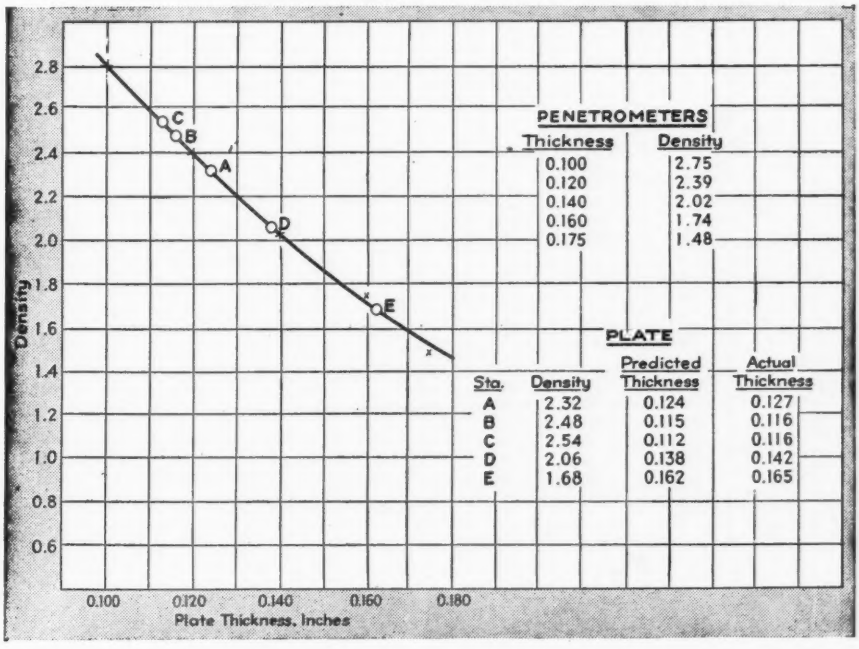


Fig. 3. Table for determining plate thicknesses from penetrometer readings of exposed film.

Analytic Geometry For Speedier Wing Lofting

Part I

By **R. W. FEENY,** *Loft Engineer, Northrop Aircraft Inc.*

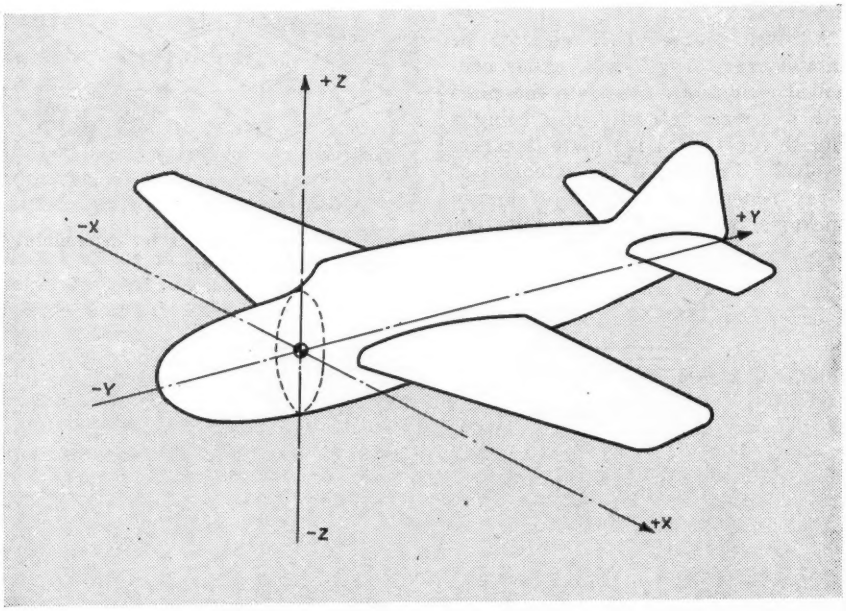


Fig. 1. Method of laying out axes of airplane. Y-Y is longitudinal center line. X-X and Z-Z cross at point where leading edge of wing meets Y-Y.

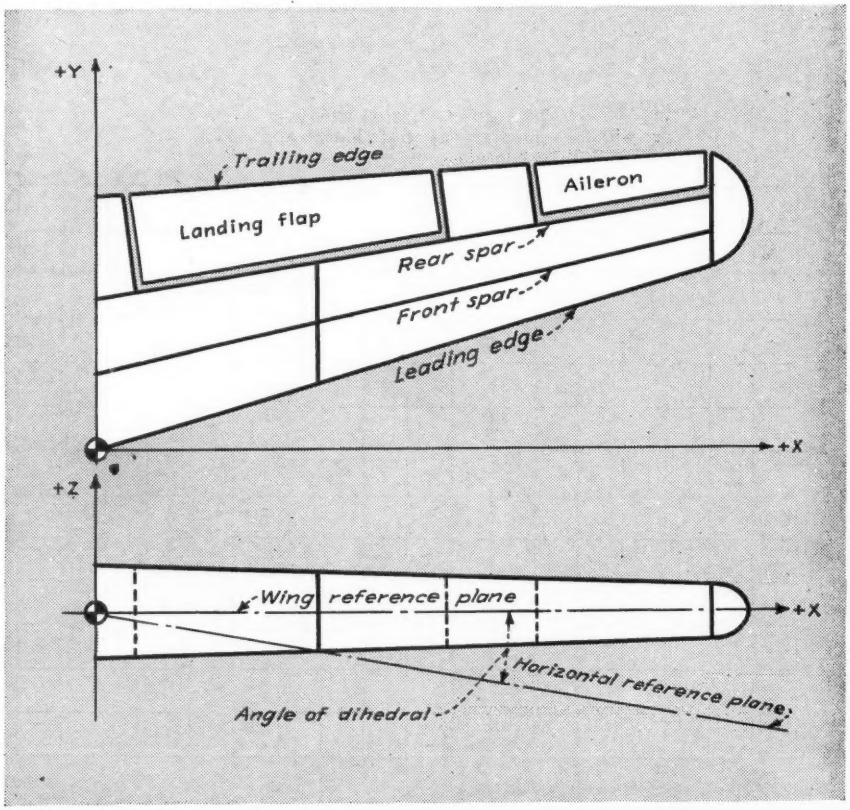


Fig. 2. Reference planes of wing. These are laid out from origin on center line.

This simple mathematical method, combining the best algebraic and trigonometric features, offers new efficiency in the solution of complex wing-layout problems.

ONE OF THE MOST BENEFICIAL RESULTS from the use of analytic geometry is in the solution of problems encountered in the development of the curved and straight sections found in the aircraft wing.

Mathematics have long been used in the determination of wing basic structures, though seldom have these calculations involved the use of anything other than algebra and trigonometry. Now, however, by combining the best features of both of the latter in the use of analytic geometry it is possible to obtain additional required information at a swifter rate than was previously possible.

Use of analytic geometry involves the establishment of equations for basic structural members, such as spars, canted or skewed wing stations, control surface hinge lines, and control cables. Once these equations are obtained, the important locations of intersections between the spars and canted stations may be found. Intersections of the control cables and bulkheads or canted stations, and their angles of intersection, are also easily obtained. Applications of the principles involved require only a basic knowledge of algebra.

In order to use analytic geometry for determining the dimensions within the airplane, it is first necessary to determine a set of axes from which calculations can be based. When considering the complete airplane, these axes are usually set up as follows:

The *origin* is located at fuselage station *O* on the vertical center line of the airplane and on the horizontal reference plane. The *Y* axis is considered to be the intersection of the vertical center line of the airplane with the horizontal reference plane. Since fuselage stations always increase numerically in an aft direction, the posi-

tive direction of the Y axis is always aft.

The X axis is a theoretical line in the horizontal reference plane normal to the center line of the airplane. This axis is considered as being in the plane of the fuselage station O with its positive direction outboard to the left.

The Z axis is a vertical line normal to the horizontal reference plane contained within the vertical center line of the airplane. Its positive direction is up. (See Fig. 1.)

In this system, the origin is determined usually by the theoretical intersection of the leading edge of the wing with the vertical center line of the airplane and wing reference plane. In using this method the X Y plane is considered to be the wing reference plane, and all normal wing stations are considered to be vertical to this plane. The y z plane, therefore, is the reference plane contained within wing station O set at 90 deg. to the wing reference plane. And the X Z plane is considered to be a theoretical plane at right angles to the above two planes and going through the intersection of the leading edge at wing station O. (See Fig. 2.)

Any structural point within the wing may then be defined by giving its X, Y, and Z coordinates. For example: The upper ML of the rear spar at wing station 68 may be stated to be located at (68, 73, and 7.4). The coordinates are stated in alphabetical order. Above coordinates mean that the point is located 68 in. from wing station O, 73 in. aft of the leading edge at station O, and 7.4 in. above the wing reference plane. Note how this simplifies the method of dimensioning the location of any point within the wing.

Before any calculations can be made, it is necessary to obtain basic equations for the important structural wing members. These should include the equations of leading edge, trailing edge, front spar, rear spar, and any auxiliary planes. To obtain the size and shape of any canted wing stations, it is also necessary to have equations of all the percent lines.

To determine the equations of any one member, we consider it as a straight line in the plan view. It is therefore only necessary to write the equation of a straight line in one plane. This method will work for all planes which are normal to the wing reference plane and therefore normal to the X Y plane.

Equation of a Line in One Plane Only

To write the equation of a straight line, we must know certain facts, namely its direction and location with respect to the origin. It will be determined, for example, if we know two points on the line, or if we know the location of one point and the slope of the line. The method most easily followed can be called the point slope method since all lines can be defined in terms of a point on the line and the slope.

Thus, if two points are given, they can be used to determine the slope, then either of the two may be used to determine the location of the line.

Point Slope Method

Equation of a line can be written in general terms as—

$$Y = mX + b$$

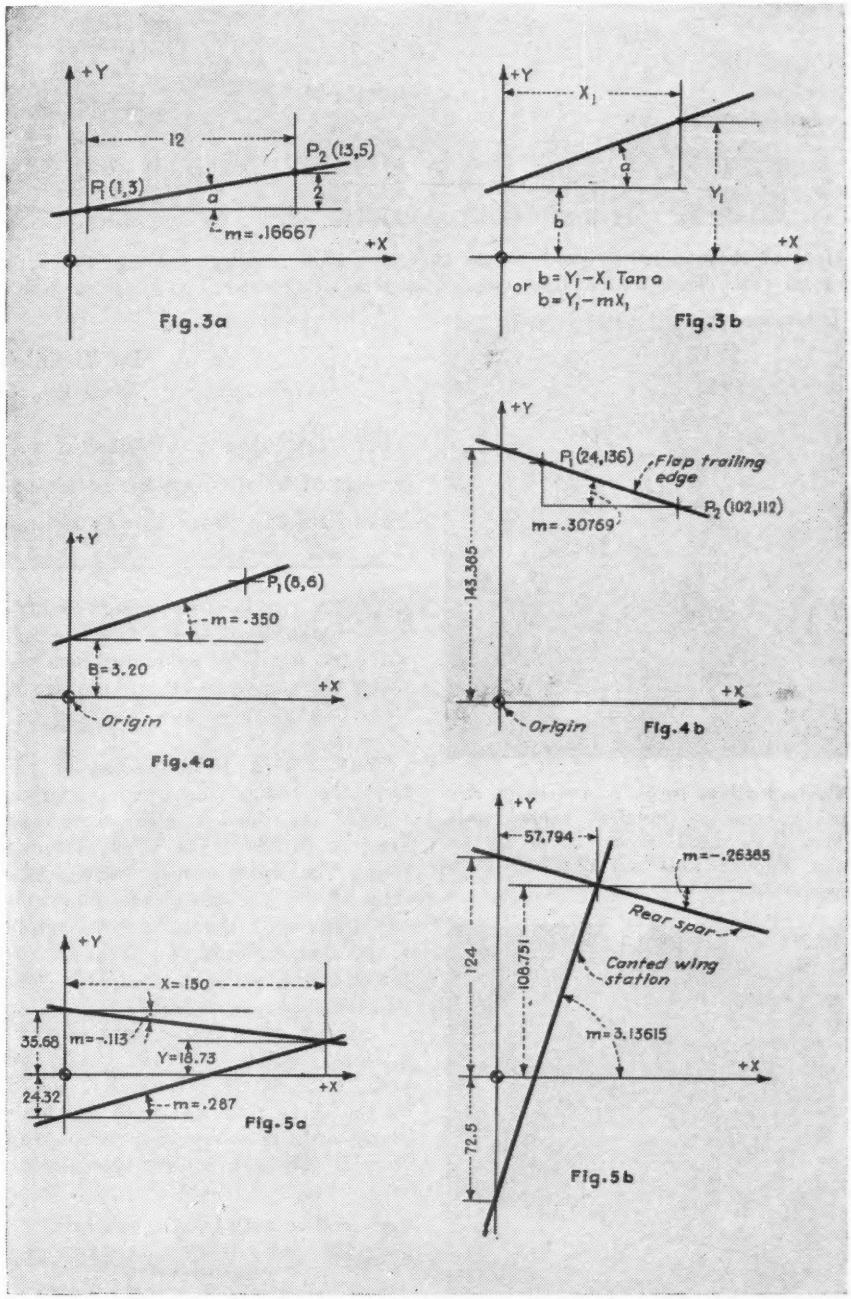
where Y is equal to the Y ordinate of any point P^1 on the line and m is called the slope of the line and can be defined as the tangent of the angle between the line and the X axis. X is the X ordinate of the point P^1 on the line, and b is the Y value as the line crosses the Y axis, or when X is equal to zero.

Slope of a Straight Line

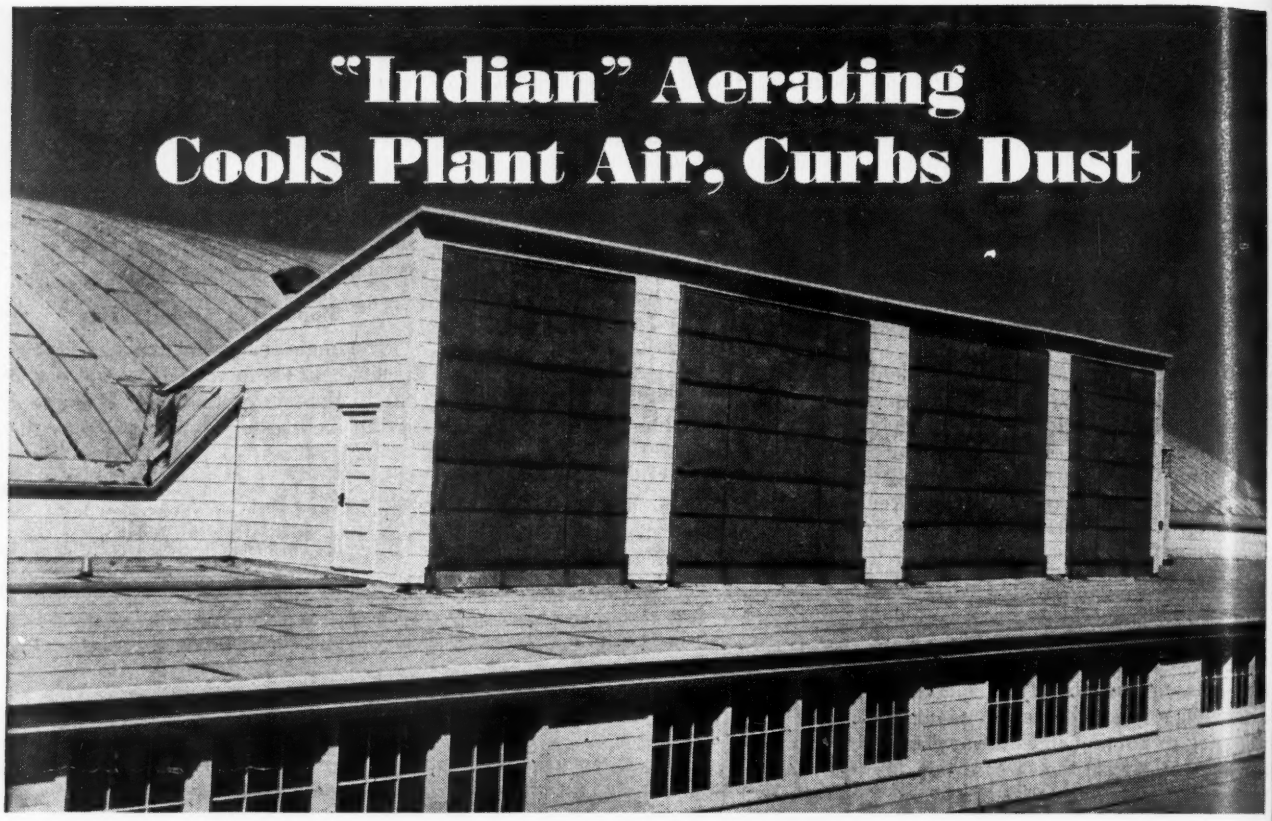
The angle that a line makes with the positive direction of the X axis is called the inclination of the line. If angle α is the inclination of the line, then the

(*Turn to page* 291)

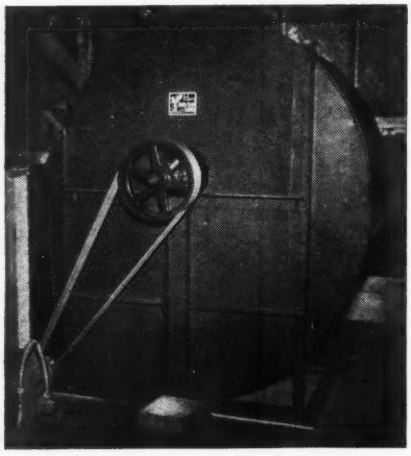
Figs. 3a, 3b, 4a, 4b, 5a, and 5b. Diagrams used with equations (see text) for obtaining necessary dimensions in airplane design, such as locating intersections of spars and canted wing sections.



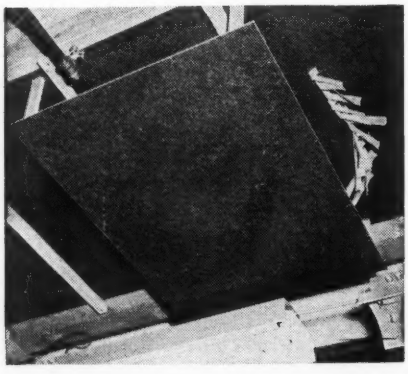
"Indian" Aerating Cools Plant Air, Curbs Dust



Eight of these aerating pent houses have been built around hangar roof. Their front-facings comprise hangings of excelsior padding. Perforated pipes at top keep pads moist, evaporation cools air drawn in by fans, and dust is eliminated.



Blowers driven by 5-, 7-, and 10-hp. electric motors are installed behind pads. They draw 1,024,000 cu. ft. of air per min. through pads and distribute it to hangars.



Each ceiling outlet has a wallboard baffle. Note paper strips fixed alongside to give visual indication of airflow.

By KNEELAND JENKINS

Plant Engineer, Tucson Div., Consolidated Vultee Aircraft Corp.

Years ago, the Southwest-desert native hit upon the "Olla" as a means of freshening his drinking water. Today, hangar-conditioning based on the same simple principle speeds "Liberator" output.

OUT IN THE hot, dry, desert country of the Southwest, war workers will turn out B-24 *Liberator* bombers faster this summer—because the American Indian knew how to keep his water cool.

With a keen understanding of nature, the Indian fashioned a porous earthen jar, filled it with water, and hung it in the shade of a mesquite tree. The water seeped through the sides of the jar, and as the hot winds swept against it the water was rapidly evaporated, chilling the sides of the jar and cooling the water it held. *Olla* was the native name for it.

In the Tucson, Ariz., plant of Consolidated Vultee Aircraft Corp., we pour 1,024,000 cu. ft. of air, cooled by the same principle, into the huge plane hangars every minute to keep aircraft workers comfortable during the hot summer months. The Tucson installation is the largest of its kind in the world—also the simplest.

When Army and company engineers set out to design and build this country's first aircraft "tailoring" plant at Tucson, the fact that from five to six months of the year the temperature hovers between 95 and 105 deg. F. had to be seriously considered. In the old days the Arizona natives took it easy from May to October, pausing each hot afternoon for three hours of siesta. But obviously, a vital plane producing plant can't shut down. To keep planes moving to the fighting fronts as rapidly as possible, men and women have to stay on the job at their maximum efficiency. We realized that during the hot months we had to have working conditions as nearly ideal as possible.

So we turned to a local firm—the Tidmarsh Engineering Co.—for assistance in conditioning the large hangars.

(*Turn to page* 312)

The B.F. Goodrich Airplane of the month

PIPER "GRASSHOPPER"

Far cry from the helpless balloons of the last war, this war's "eyes of the artillery" are highly maneuverable radio-equipped Piper "Grasshoppers." Wartime version of the famed Piper "Cub," it carries keen-eyed observers right over enemy positions where they can call the shots and get them on the target fast. These "flying jeeps" get under cover fast, too, when the occasion arises. The ability to set down on a small field or on a highway is just one of this versatile little plane's *big* advantages. And artillery spotting is just one of its many *big* war jobs.

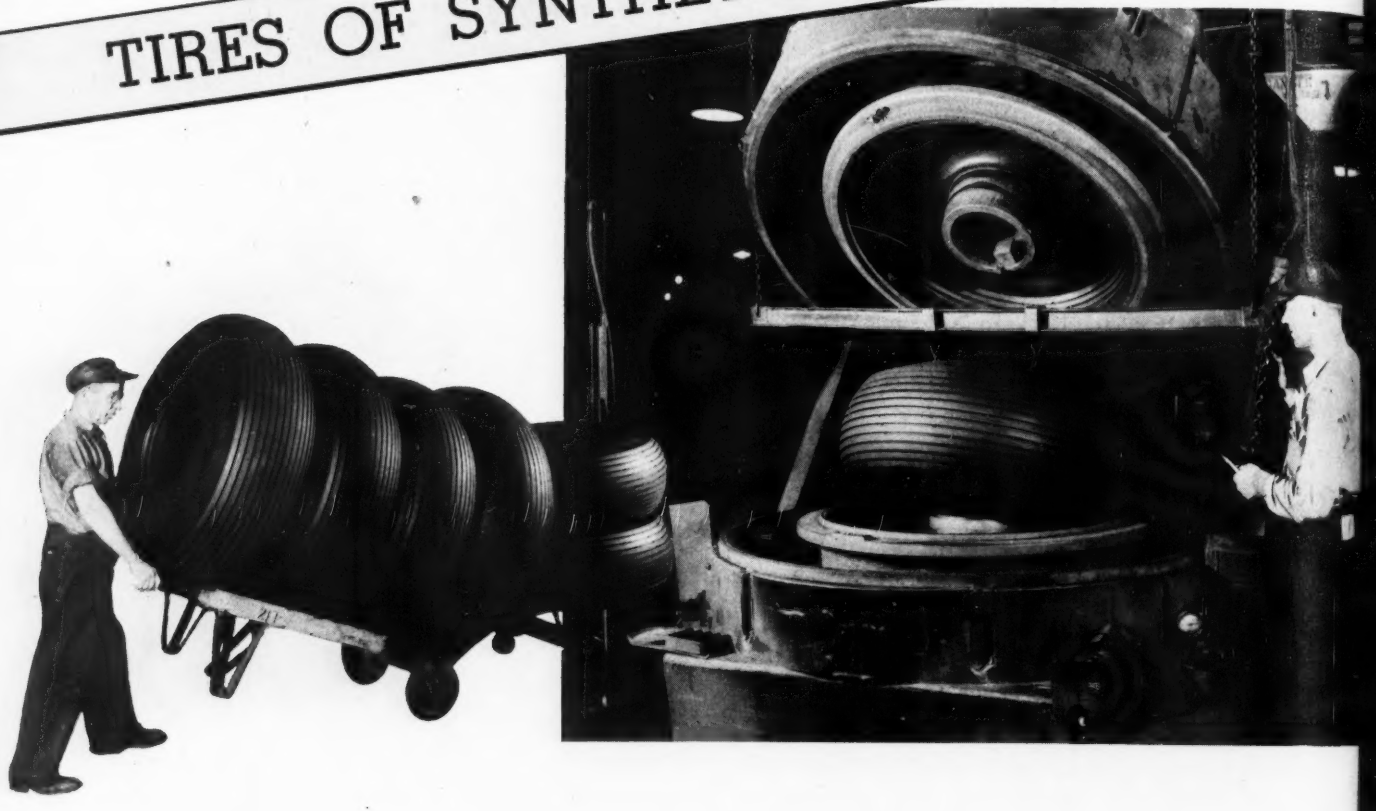
B. F. Goodrich—makers of Airplane Silvertowns, Expander Tube Brakes, De-Icers, Bullet-Sealing Fuel Cells and many other essential aircraft products—salutes the men and women of Piper Aircraft Corporation who build the "Grasshopper"—our choice as "Plane of the Month."

In war or peace

B.F.Goodrich

FIRST IN RUBBER

. . . . PROGRESS REPORT ON AIRPLANE TIRES OF SYNTHETIC RUBBER . . . . .



The use of synthetic rubber has now been extended to airplane tires in all sizes and for nearly all types of service. A concise report on how these tires compare with natural rubber is not practical, because the proportion of synthetic varies from size to size. In some tires 70% of the rubber used is synthetic; in others only 35%. All-synthetic test tires have been made. The conversion to synthetic rubber was first limited to substituting synthetic rubber in the tread stock, and this was followed in many sizes by using increasing amounts of synthetic rubber in the carcass as well.

Airplane tires have some inherent qualities that make them more easily adaptable to synthetic rubber than tires for other types of service. For example, airplane tires have been held to a minimum thickness of carcass and tread, in the interest of weight control, and this has proved an advantage in controlling the greater temperature rise in synthetic rubber tires.

As tires for the various services have been released, their dependability and safety, under proper care, has been assured by exhaustive laboratory and service tests. Their service life, on the other hand, is not so easily determined. Only months of record-keeping and careful checking can provide the accumulation of evidence necessary to evaluate synthetic tires in terms of life expectancy. Reports from early airline tests are indicative of what may be expected, however, and performance figures so far accumulated do not show any radical modifications in such important qualities as tread wear, bruising, cutting resistance and weight.

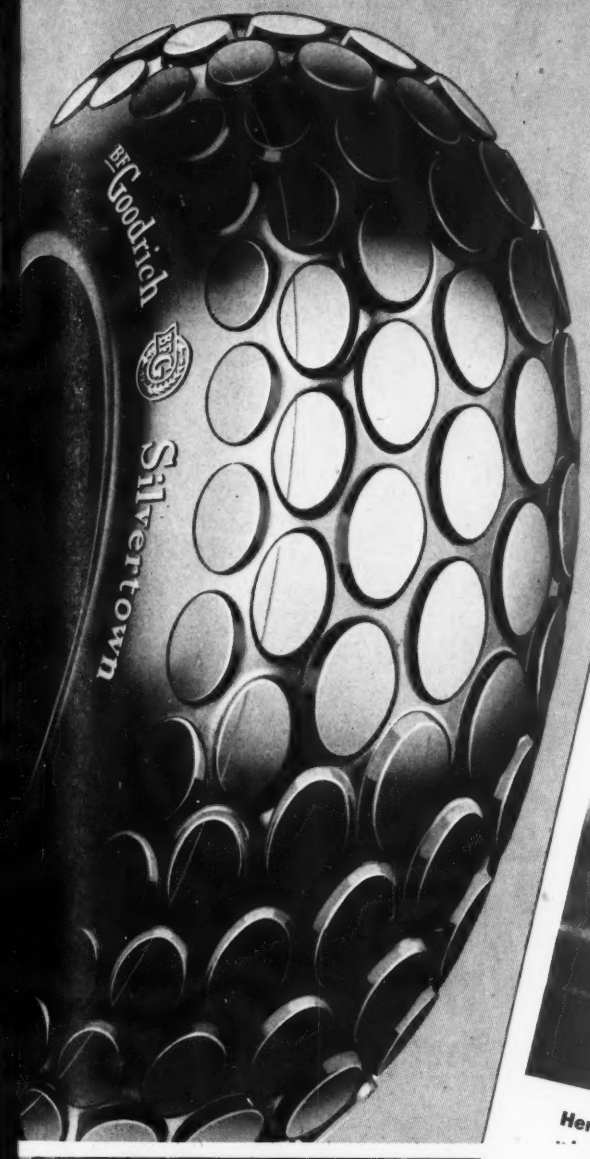
The B. F. Goodrich log of experience in synthetic materials covers years of research and leadership in the development of many special-purpose rubbers. In June, 1940, passenger car tires in which more than half the rubber was B. F. Goodrich synthetic (Ameripol) were sold to American motorists. These were the first synthetic rubber tires offered for sale in America.

This background of experience, along with reports on both laboratory and field tests on airplane tires, led to the approval, by the Civil Aeronautics Administration in March, 1943, of synthetic B. F. Goodrich Silvertowns for commercial air lines.

MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

ARMY E NAVY

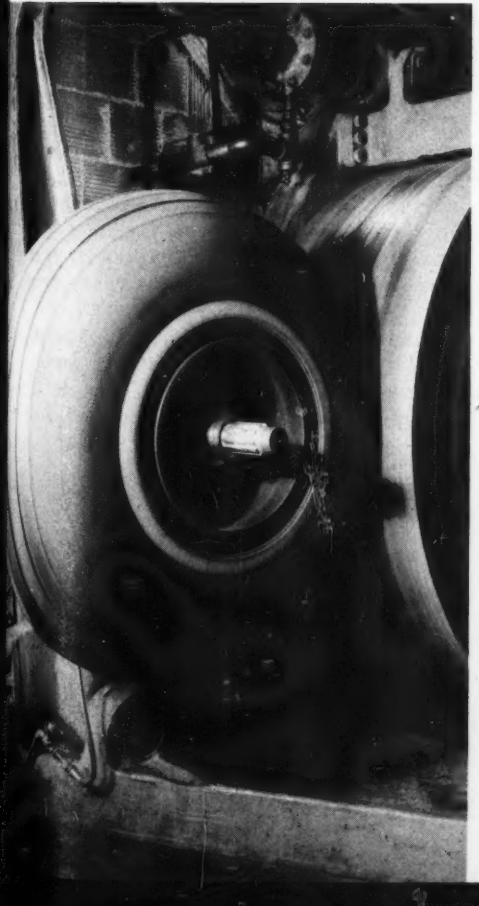
Awards to 9 plants



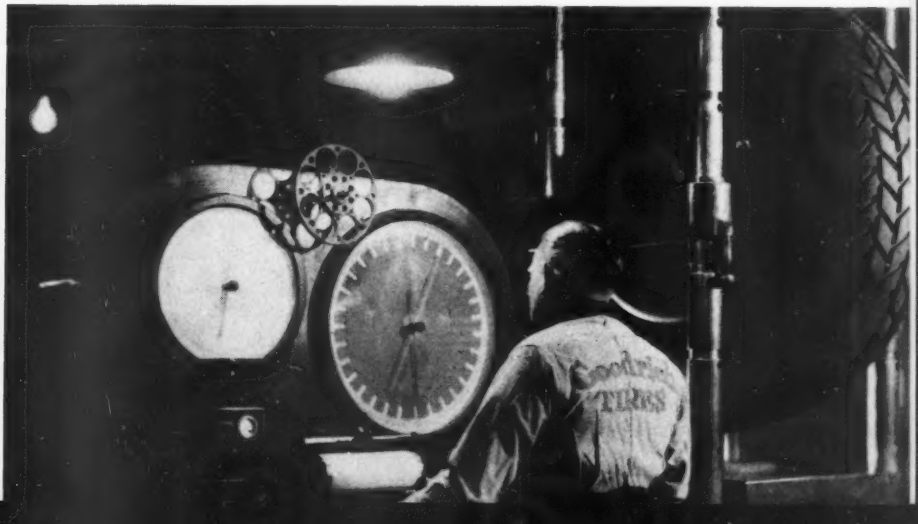
NEW SYNTHETIC RUBBER BOMBER TIRE with unusual non-skid tread design. This is one of many types of all-synthetic or partially synthetic tires now coming off B. F. Goodrich production lines.

SYNTHETIC TIRES for planes OK'd by C.A.A. Another B.F.Goodrich "first"

FIRST SYNTHETIC TIRES to be approved for use on commercial airlines by the Civil Aeronautics Administration were B. F. Goodrich Ameripol Silvertowns. This approval was granted on the basis of extensive tests made by B. F. Goodrich plus the performance of other types of B. F. Goodrich synthetic tires then in service.

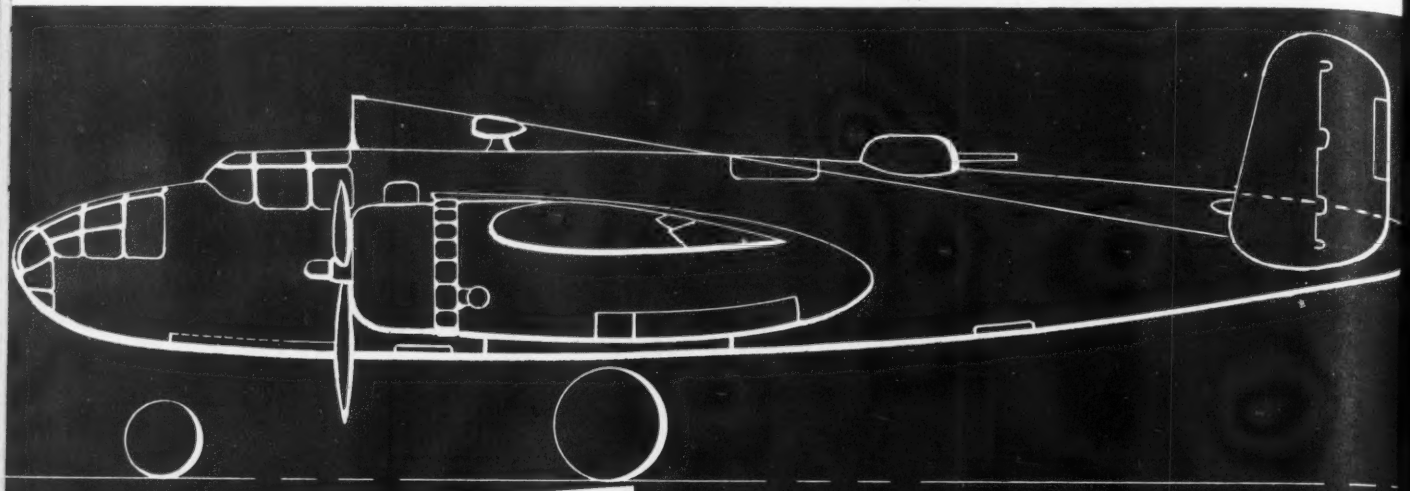


OUR TORTURE CHAMBER TESTS help tell in advance how synthetic rubber tires will perform in service. The huge road wheel on the machine at the left simulates landing and take-off speeds up to 150 miles per hour. The number of landings of given loads at various speeds can be determined here with considerable accuracy. Below is a test for bruise-resistance.



For FASTER FASTENING

from nose to tail



A FEW TYPICAL APPLICATIONS OF THESE UNIQUE FASTENERS

- For attachment of plastic in nose and turrets.
- In cloth-covered wings, ailerons, rudders, elevators and trim tabs.
- Fastening fillets and fairing.
- Fastening flooring in plane or on work platforms.
- Fastening bonding wires.
- Fastening clips, brackets, etc. for conduits.
- Attachment of insulation and upholstery.
- Building light frames.
- Spacers for soundproofing and insulation.

Use B. F. Goodrich RIVNUTS

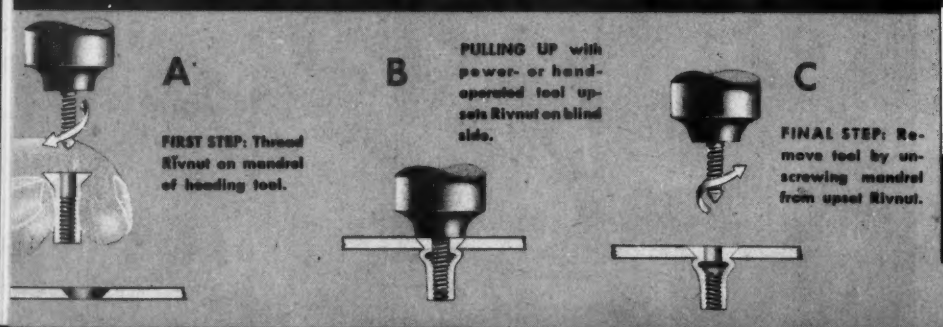
as Blind Rivets or Nut Plates or both!

The list at the left points out a *few* of the places B. F. Goodrich Rivnuts can be used to speed airplane assembly and cut costs. There are many more. In fact, on acquaintance with this unique fastener, you could probably make a new list of uses just as long for your own assembling operations.

Rivnuts combine light weight with strength; simplicity of design with low cost; easy installation with efficient performance. They have a wider bearing area than any other blind fastener, yet are compact and fit a smaller hole. All these advantages, and many others, can work to *your* advantage in airplane construction.

Our manufacturing capacity has been expanded so that we can fill all normal orders without delay. Get complete facts now by writing to The B. F. Goodrich Co., Aeronautical Division, Akron, Ohio.

RIVNUT INSTALLATION IS AS EASY AS . . .


A
FIRST STEP: Thread Rivnut on mandrel of heading tool.
B
PULLING UP with power- or hand-operated tool upsets Rivnut on blind side.
C
FINAL STEP: Remove tool by unscrewing mandrel from upset Rivnut.

In war or peace

B.F.Goodrich

FIRST IN RUBBER

Informal mass meetings featuring slide-films with sound effects prove effective way of training foremen in personnel handling methods.

Slide-Films Promote Employee-Relations Training

By LYNE S. METCALFE

How modern method of training foremen in the field of human relations brings new successes in industrial operations.

AT A TIME when the aircraft industry needs maximum work and workmanship, it is the supervisor of foreman who can help most by listening to employees' ideas—and complaints—and doing something about them.

Now, when all available manpower must be conserved, it is the foremen or supervisors who can, by properly "handling" of workers, win their best efforts and keep them satisfied on the job. It is noteworthy that the nation's largest employers of labor are eager to exchange ideas and methods in training and employee relations programs. Accordingly, Carnegie Illinois Steel, with one of the outstanding foreman training operations of all war industries, prepared a program, auxiliary to its regular training system, comprising five sound slide-films so effective, and with pictured material so broad and general, that it was decided to let any employer in the aviation industry use the program.

With each of the slide-films is provided a disk record having voices synchronized with the pictures. Each unit deals with a basic problem or situation as common to the aircraft industry as to the steel business. These "visuals" do not deal with plants or equipment but only with *people*—that is, the common reactions of people to certain "patterns" of handling and treatment. For those not entirely familiar with this training medium, it may be explained that a slide-film is a strip of 35 mm. safety motion picture film, on each segment or "frame" of which is a picture. All pictures are especially photographed and arranged in logical sequence to set up a foreman-worker situation, also to suggest the proper conduct to meet it.

Dialogue between foremen and workers as they are pictured comes from the record. Thus, the foreman or supervisor in the aircraft plant is shown, simultaneously, what to do, what to say, and how to say it. All the points illustrated are based upon established company policies and upon the experience of many years in this field of training personnel. As stated, the material is so broad and fundamental that any aircraft plant can easily use it as an integral part of whatever supervisory training activity may already be in use. Each slide-film and record unit is the basis of a single foremen meeting or session. General procedure:

1. Introduction of the subject by a qualified leader (usually a member of the aircraft plant personnel training department) with comment and elaboration to stress points of particular interest in that plant.
2. Projection of the picture and running of the synchronized record.
3. Open discussion under guidance by a meeting leader or leaders, with exchange of ideas and experiences by the foreman or supervisors.
4. Second showing (optional).
5. Questions-and-answers session.

It will be seen, therefore, that these films and records furnish only the basic material for the meetings. They are designed to provoke discussion, thus bringing out in open meeting the views of the foremen attending. All this, of course, is of the utmost value in making the meetings successful.

Attendance at these meetings is not compulsory. Supervisors and foremen are merely invited to be on hand. However, Carnegie found attendance to be very nearly 100 percent. Furthermore, in a questionnaire, recently given the company's 4,800 foremen and supervisors, to determine what form of meeting they think most effective, the vote was overwhelmingly in favor of this type of visual presentation.

Lt. Comdr. Harry J. Marx, USNR, Head of hydraulic section, Bureau of Aeronautics, U. S. Navy Dept.

Prime Axiom In Hydraulics Is *Banish Dirt*

By LT. COMDR. HARRY J. MARX
*USNR, Bureau of Aeronautics, USN**

Foreign matter stands revealed as Enemy No. 1 of aircraft hydraulic systems—the instigator of all manner of difficulties impeding their efficient operation. But these troubles can be licked with adequate filtration, proper training, and a crusade against carelessness.

IN ORDER TO CONVINCE a group of skeptics, the writer once set up a complete hydraulic system with proper filtration and clean fluid. Every unit was tested and checked for perfect operation, and no trouble was encountered with any part of the system.

Then the filter unit was removed, the top cover of the reservoir was left off, and ordinary dust and fine sweepings were introduced into the fluid.

The effect was apparent within a few moments. The hydraulic pump, which was electric-motor driven for laboratory use, began to hum a new tune—a complaining tone. And the cut-in and cut-out of the pressure regulator began to fluctuate. At times, the actuating cylinders would actually stop until pressure could build up—because the regulator was by-passing in spite of the fact that pressure was running below the cut-in point.

Furthermore, cylinders started creeping because of leakage in the selector valve. Check valves did not seat properly, hence pressure was lost. Restrictors clogged up, and for operations which normally took 8 sec., 15 were required. All this continued until the pressure regulator jammed, after which the pump stuck and the shear link was broken. (And we muse over the reports recommending stronger shear links.)

Moral to all this is that dirt is the potential enemy of any hydraulic system. Not only does it stop the various units from functioning properly, but it scores the cylinders, cuts the packings, and scratches the piston rods. Leakage is created, together with further malfunctioning.

The logical solution for the elimination of dirt is *adequate* filtration. The type used in the past has been far from adequate. First, the filter in some systems is in the pressure line leading from the engine-driven pump. This means that the pump has to labor with the dirt, although the system receives some protection. Due to pressure drop through the filters, some hydraulic systems carry the filter in the return line to the reservoir. Why the reservoir should be protected *after* the dirt has been distributed all through the system remains a mystery!

For proper diagnosis of the causes of the dirt, we decided to call in one of the country's foremost authorities on the subject of dirt control in hydraulic systems—Jules Kovacs, chief engineer of the Purolator Products

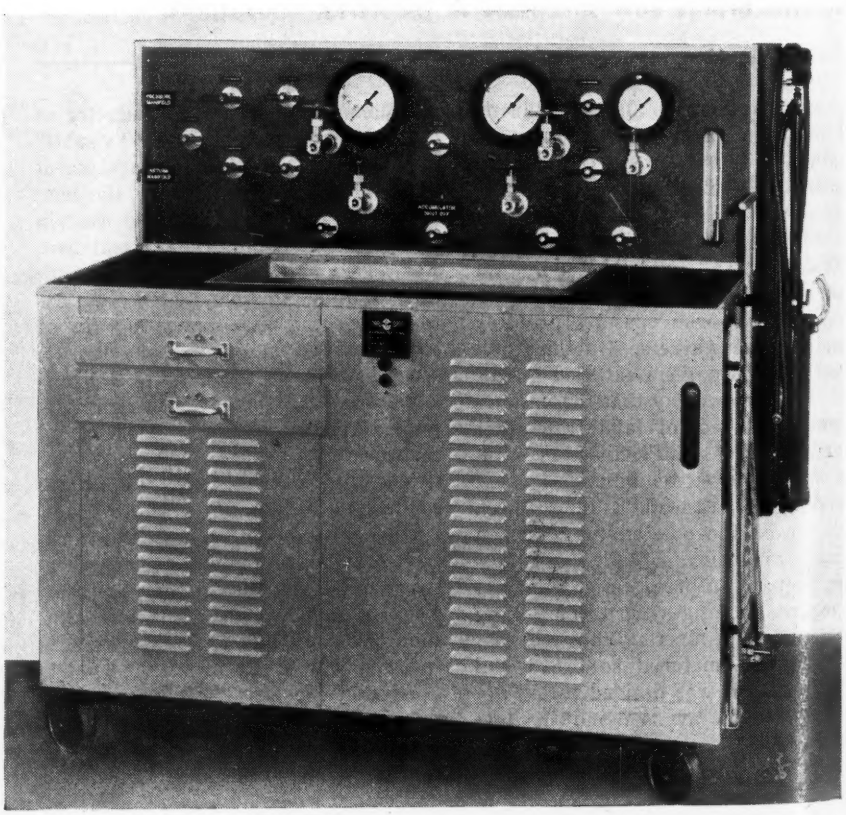


Fig. 1. Combination portable test stand and oil filler unit. (Greer Hydraulics photo.)

* In the author's various articles, opinions and representations are his own and should not be construed as expressing or reflecting official Bureau of Aeronautics views.

Fig. 2. Ring packing shredded by improper clearance. (Chance Vought photo.)

Co., a man who has spent many years in this field.

First of all, in a comprehensive analysis of hydraulic oil as purchased, it was found that a small amount of dirt exists in suspension because of inadequate filtration by the oil manufacturer. Also, it was found in many cases that there was water in the barrel with the oil. This water occurred through condensation of moisture in the air, or it was drawn in through the barrel bung hole. The greatest cause for dirt was found in the fact that the barrels themselves are often quite dirty.

Further investigation brought out the fact that oil drums could not be properly cleaned or kept clean. Another contributing factor was the method of draining the oil from the barrel into the airplane hydraulic system. It was found that careless mechanics dropped the hose end onto the ground and dragged it through the dirt before inserting it into the barrel or container.

It was also discovered that the bung hole was left open for long periods, allowing dirt, water, and other foreign matter to be drawn into the drum or to be dropped into the oil by careless handling. Sometimes, hose made of unsuitable material deteriorated and the resulting bits and slough found their way into the airplane system. In one case, it was observed that a mechanic on a well organized field, when bleeding a hydraulic brake line, picked up a dirty tomato can containing sand and dirt and ran the fluid into it. Then, to the horror of the observers, he dumped the resulting mess into the oil reservoir.

The above problems are due almost entirely to gross carelessness and lack of education. Cure here is in thorough training of ground crews.

Proper and only recognized method of filling airplane hydraulic systems is from a test stand containing a large micronic filter through which oil from an external reservoir can be properly cleaned—not only of dirt but also of

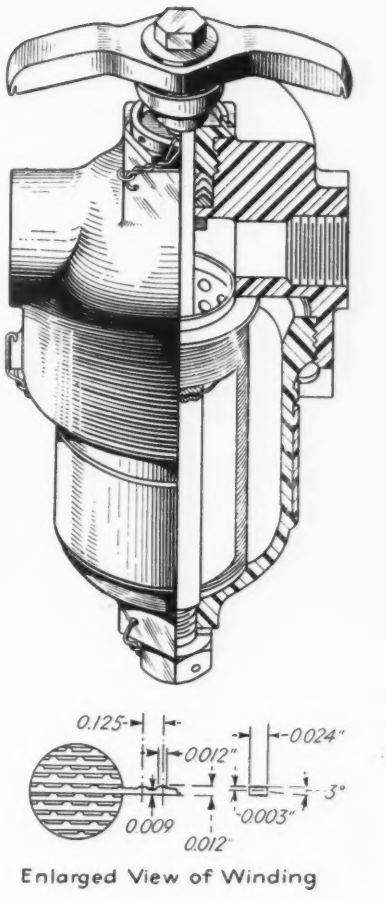
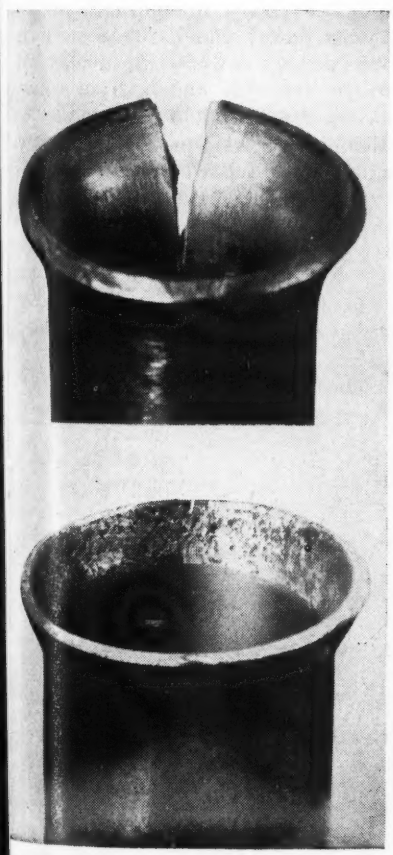


Fig. 3. Knife edge cleaning, metallic element filter. (Purolator Products Co. photo.)



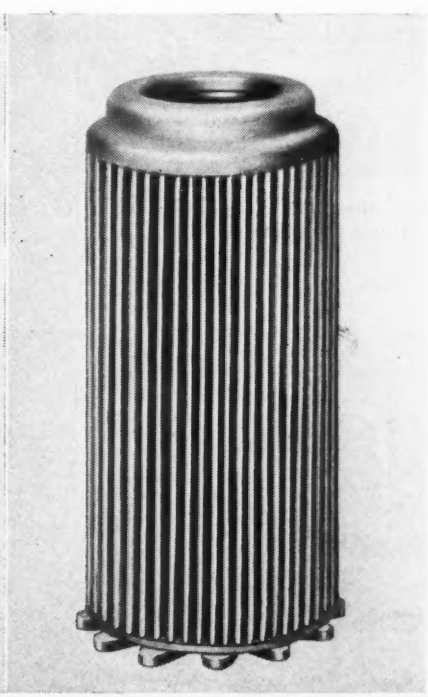


Fig. 4 (above, left). Micronic line-type replaceable-element filter. **Fig. 5** (above right). Replaceable filter element for unit shown in Fig. 4.

Fig. 6 (left, above). Split flare on tube end. **Fig. 7** (left, below). Pock marked flare on end of tubing. (Parker Appliance Co. photos.)

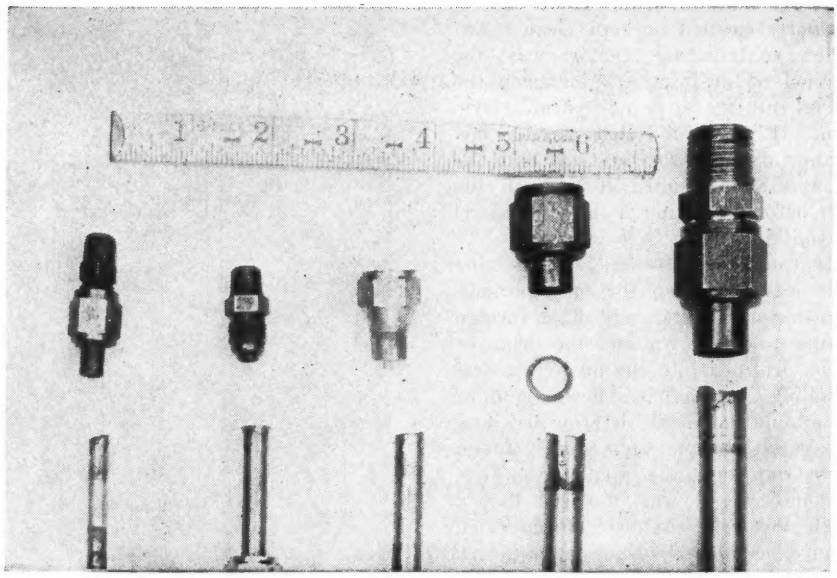


Fig. 8. Failures in tubing due to faulty workmanship. (Naval Aircraft Factory photo.)

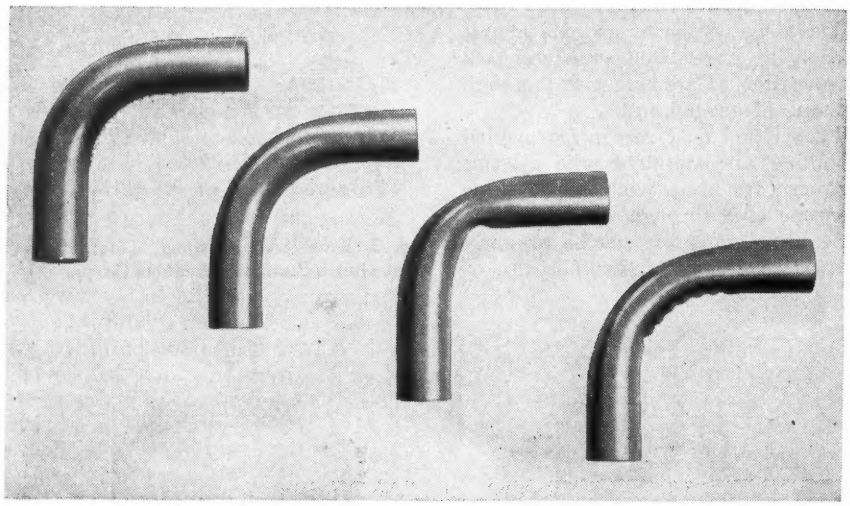


Fig. 9. Bends in tubing. Left to right: Correct, flattened, kinked, and wrinkled. (Parker Appliance Co. photo.)

the water which may be in the oil—before it is allowed to enter the airplane hydraulic system. It is also necessary that the test stand be capable of flushing and filtering the oil used through the airplane system, thus eliminating all trapped foreign matter and air. This type of machine is shown in Fig. 1.

Further investigation resulted in the finding of dirt and metallic shavings in the airplane hydraulic system itself. Tubing allowed to stand with open ends had gathered dirt, and flaring of tube ends had resulted in chips and shavings falling in. Dirt was also gathered while assembling into components or it was inserted while testing. It was found in many cases that where mechanics disassembled a faulty valve, lint was left on parts while cleaning them with rags.

Furthermore, dust gathered in housings and was not cleaned out, and parts were dropped on the floor and not thoroughly cleaned before reassembly. Also, incorrect cylinder clearances made packings shred and the resultant shavings caused trouble. An illustration of such a piston packing is shown in Fig. 2. Scoring of pistons or cylinder walls introduced shavings which in many cases caused trouble by keeping valve poppets open. When the oil level in the hydraulic reservoir falls, air is drawn into the unit. This air may contain moisture which condenses into water, destroying the fine finishes necessary in hydraulic units. Another thing: Sand, found in dust storms as high as 30,000 ft. and drawn into the reservoir and hydraulic system, has caused untold damage.

Remedy for these problems is fairly simple if the following rules are observed: First, there should be correct

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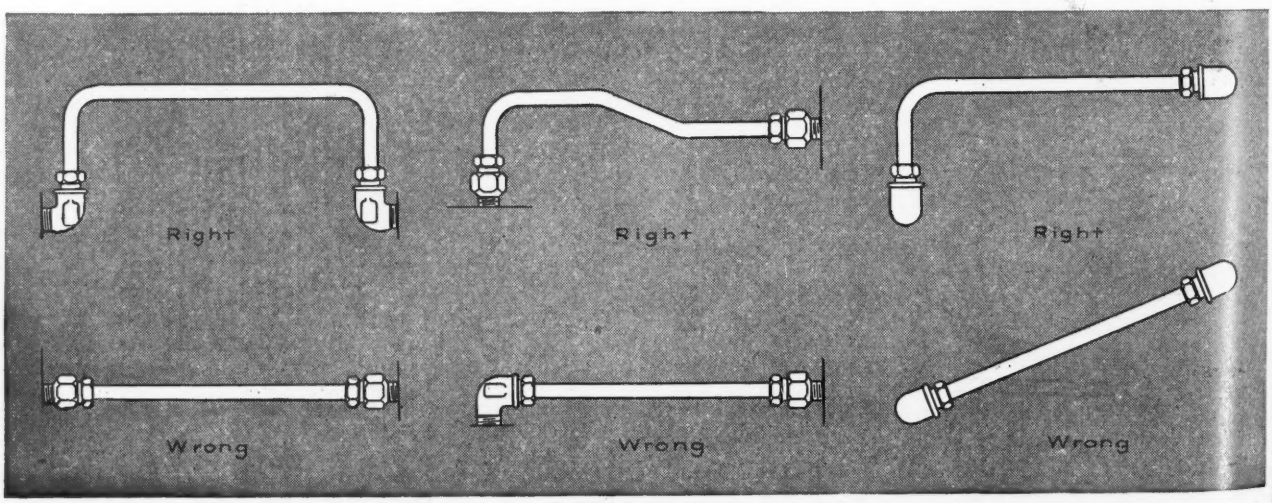


Fig. 10. Right and wrong methods of installing tubing and fittings. (Parker Appliance Co. photo.)

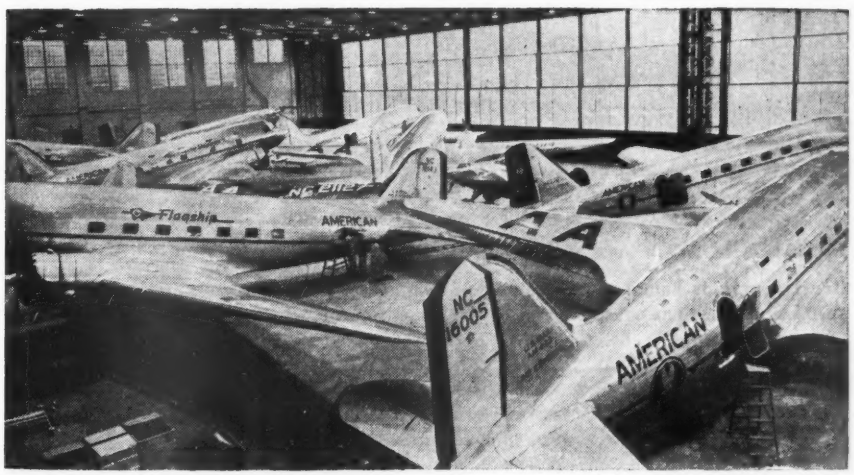
Maintenance Section

Airlines Play Safe On Fire Hazards

By HERMAN SCHLOSSER

Chief Plant Engineer, American Airlines

With up to a million dollars' worth of planes per hangar, American Airlines takes triple-sure precautions against chances of a blaze getting a start at its overhaul and maintenance bases. Here's how.



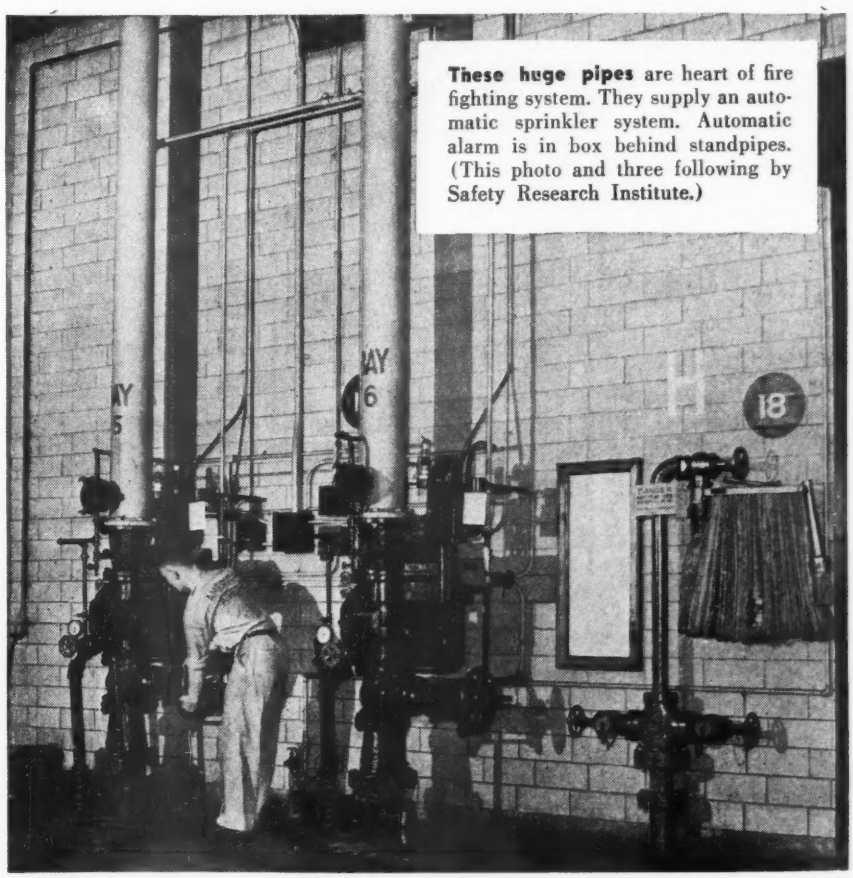
The reason for all this fire protection. This collection of *Flagships* would make a million-dollar fire. (American Airlines photo.)

PLANS FOR POSTWAR OPERATION of aviation have many facets. One of the most vital is keeping that industry and its equipment protected. The investment of man-hours and capital required for future aeronautical operations will be lost unless precautions for safety are charted now.

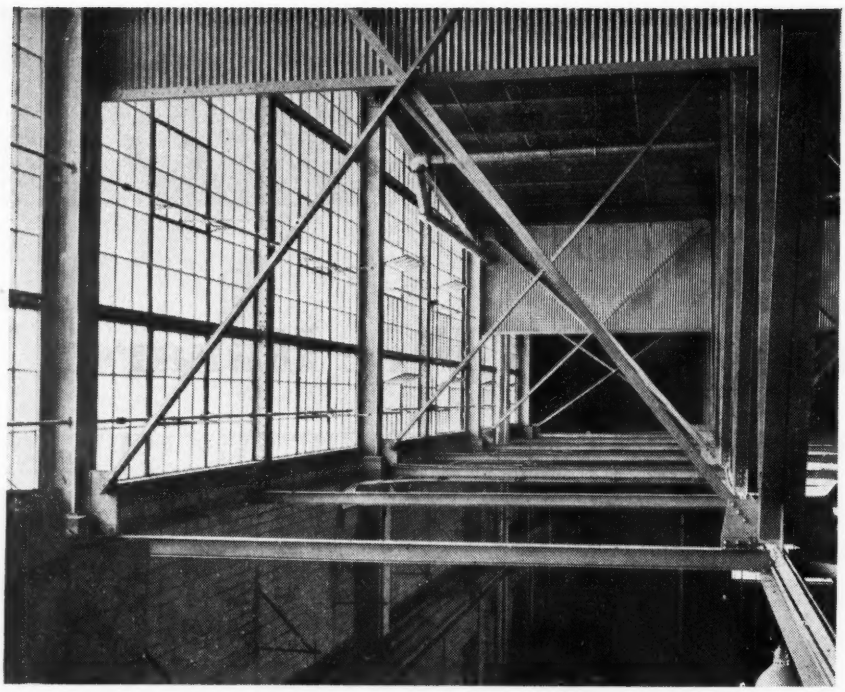
Postwar progress will call for the establishment of new large maintenance and overhaul bases. Wherever the commercial air routes of the future go, adequate bases must support them. Existing bases will need expanded facilities to handle the vast increase of traffic that will come with peace. This calls for the application of sound fire protection practice to the plans now in the making.

It may be well that the progress of commercial aviation during its first quarter century was made at a relatively slow pace—relative, that is, to the meteoric progress that the war has forced upon air transport. Thereby, time was provided in which to acquire by experience and study a tradition for safety on the ground equal to that which aviation has acquired in the air.

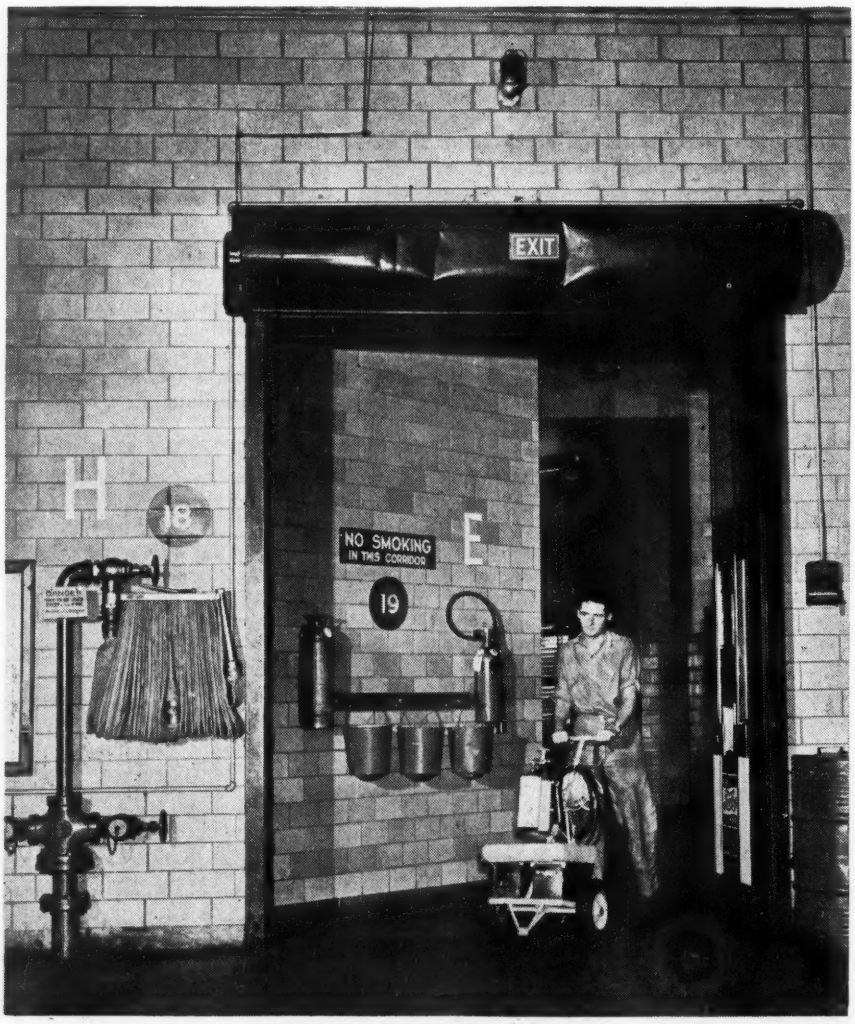
At maintenance and overhaul bases, airplanes and their parts are overhauled or replaced according to established schedules. Among the items given attention are engines, ignition systems, storage batteries, carburetors, propellers, assemblies, wing, fuselage, and tail hydraulic systems, landing gear, and many instruments. Cabin



These huge pipes are heart of fire fighting system. They supply an automatic sprinkler system. Automatic alarm is in box behind standpipes. (This photo and three following by Safety Research Institute.)



Draft curtains hanging from ceiling prevent travel of heated air which would set off sprinklers in sections not in danger.



At every exit is a heat-actuated door-closing device, standpipes and hose, fire alarm boxes, sand pails, chemical extinguishers, and rubbish container.

interiors may be renewed and seats may be re-upholstered. Gasoline and oil tanks are cleaned and inspected. Fabric-covered movable control surfaces, such as ailerons, rudders, and elevators, must be recovered and painted.

These and other minor operations create a combination of circumstances or conditions that are peculiar to the overhaul and maintenance base. Basically, the general precautions for fire protection, common to all industrial buildings, apply. Proper segregation of hazardous functions, an adequate number of fire extinguishers of proper types, adequate standpipe and sprinkler systems, fire alarm systems, trained fire brigades, good housekeeping, and proper maintenance of machinery and equipment—all are essential. But there are also certain other precautions that are necessary to cope with the special fire hazards encountered.

A tendency exists to increase the size of hangars beyond proportions that comply with good standards of fire protection. Reasons for this are twofold. Larger hangars provide better use of the floor area for plane storage; they provide for the storage of future aircraft, the dimensions of which are uncertain. However, the storage of a large number of planes under one roof does not seem advisable. A subdivision of values should be planned even at a premium in initial construction costs.

As to future requirements, the dimensions of aircraft for the next five years can be fairly well determined. Should larger aircraft become feasible after this period, it may be necessary to service them outdoors or in special nose sheds to afford weather protection for those working on the engines.

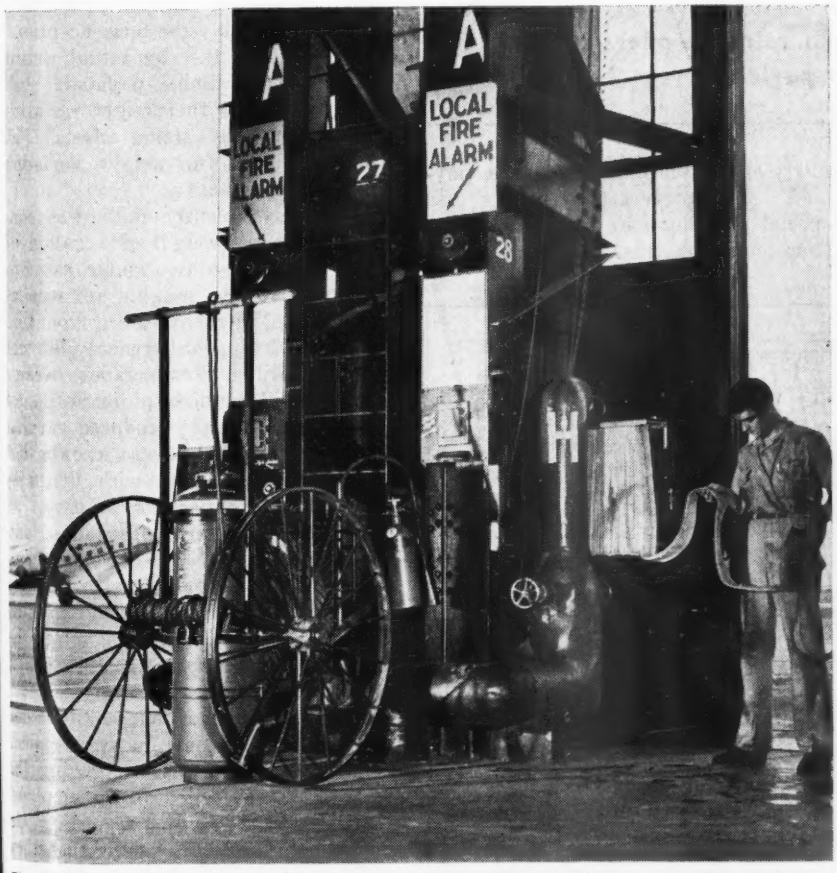
Hangars should be separated, if only by firewalls. Properly separated areas, protected by firewalls, should be provided outside of the hangars for various operations such as the following:

Engine disassembly including the cleaning of all engine parts, battery recharging, battery repairing and plating, upholstering and fabric covering, paint spraying and doping, carburetor testing, welding, cleaning of oil and gasoline tanks, and engine testing.

The remaining overhaul operations, with no inherent fire hazards, can be carried on in one large area. Included in this category are machine shop work, propeller reconditioning, engine accessories overhaul, and engine assembly. The instrument shop, although non-hazardous, must be enclosed for dust control.

Stock room work falls in the above category and it requires planning for

Spray booth is enclosed, complying with fire regulations, and has water screen at back to arrest dope fumes which might escape and cause fire hazard. (American Airlines photo.)



Fire station at hangar door has 40-gal. foam machine, standpipe connection and hose, local fire alarm, extinguishers, and control switches.

adequate aisles, metal storage bins, and racks. The large quantity and variety of items stocked simplifies the problem of proper segregation of combustible materials. Small quantities of these items can be distributed among non-combustible stock to reduce the exposure and minimize the spread of any fire.

There are, however, certain types of stock for which storage in a separate building is indicated. Included are flares, paints, lacquers, dope, and thinners. Because of the large quantity of such supplies required at overhaul bases, such a building should be located from 50 to a 100 ft. away from other structures.

Unless special precautions are taken in recognition of the hazard involved in handling fuel, above-ground storage tanks should be located a distance of at least 100 ft. from all buildings. Underground storage tanks are preferable, of course, and the hydraulic system of dispensing gasoline is the safest. In this system, gasoline tanks are always filled with liquid consisting of varying quantities of gasoline and water. Partially empty tanks, with their resulting vapor content, are eliminated, as is the venting hazard.

Administration offices also require a separate building. In the general planning, consideration must be given to

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All battery trucks are equipped with two fire extinguishers, one carbon dioxide and one vaporizing. Since these are always present with battery truck, danger of electrical fires is minimized. (AA photo.)

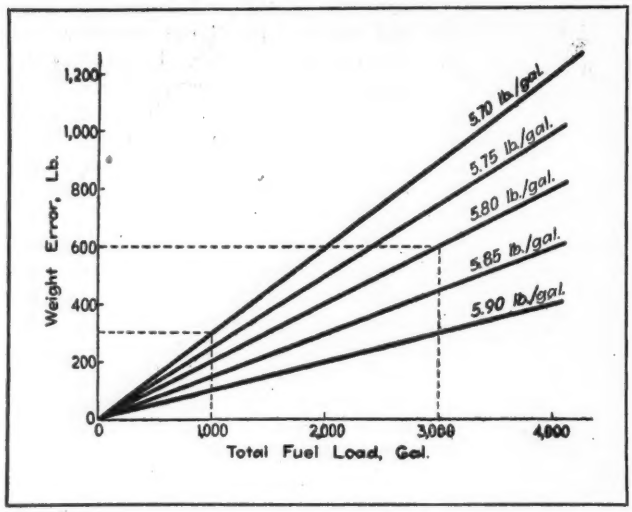

Fig. 1. Curves showing error in total fuel weight caused by inaccurate estimates of lb./gal.

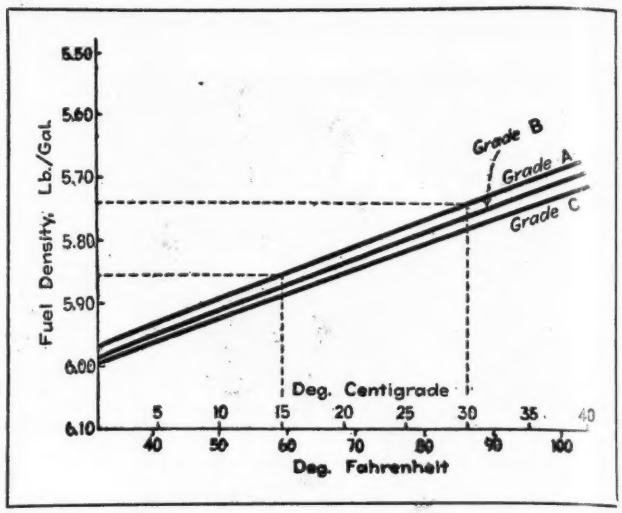

Fig. 2. Variation of fuel weight with temperature for several common 100 octane fuels.

Fuel-Weight Measures For Better Flight Performance

By **JAMES J. HEATLEY,** *Operations Engineer, American Export Airlines*

Declares the author: "Any time I'm flying 20 hr. and 208 gal. of fuel 'disappear,' I want to know the reason why." . . . Demonstrating the fallacies of the old "6-lb. rule," he offers accurate fuel yardsticks to improve balance and payload.

A RESUME of the recent developments in loading aircraft by consideration of the actual density of the fuel reveals that specific fuel weight definitely enters the field of balance, payload, and performance—which has special meaning today because of the tremendous increase in long range operation. It's importance cannot be minimized, even though there are a good many misconceptions which need to be straightened out.

We hope here to prove this importance and allay the misconceptions.

Does loading fuel by actual weight increase the available payload? . . . Might neglect of fuel-weight variation result in adverse balance effects? . . . And how does fuel-weight variation affect performance?

Until only recently, 6 lb. was conceded to be the weight of a gallon of fuel. That was a reasonable assumption because the weights of various fuels did not then vary much from that figure. Startling differences did not appear until higher octanes became common and methods of manufacture and sources of crude produced varying aromatic contents. It was known that gallon weights varied with temperature but fuel capacities were not so large that the difference produced any apparent effect. Now, however, combinations of flowmeters, quantity meters, high octane fuels, and high altitude flying in all latitudes, make the problem more complex.

At the beginning let us realize that our engines do not burn *gallons* of fuel. A gallon is merely a convenient volumetric unit to use in gaging the amount of fuel loaded on the airplane. Engines work only according to pounds of fuel—the weight that they may consume. All fuel-air ratios are based upon weights. If an engine uses,

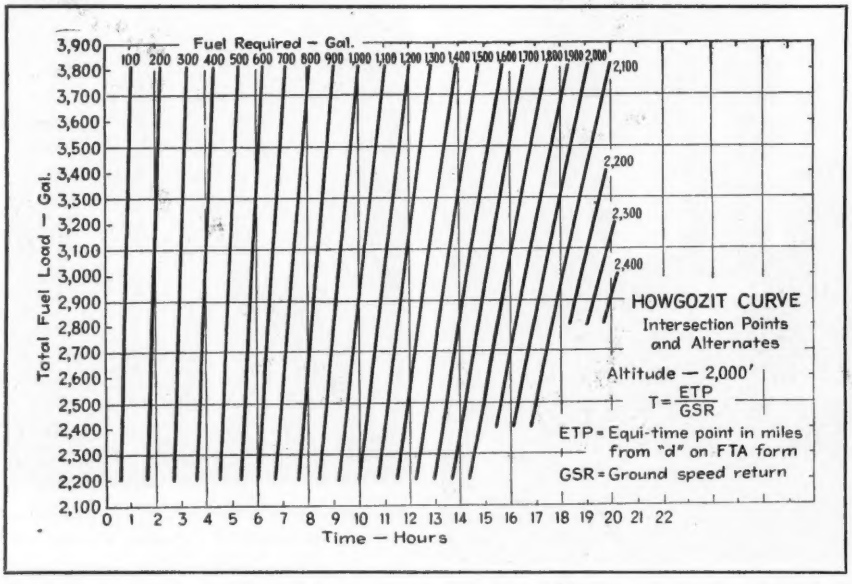

Fig. 3. Fuel required during flight may be determined with this "Howgozit" graph.

under a given power, 300 lb. of fuel per hour in cold temperatures, that 300 lb. will be contained in perhaps 50 gal. while in hot temperatures it will take 52.6 gal. to carry that many pounds. If you were flying with four engines, each burning that amount of fuel, and had no pound calibration flowmeters, each hour you would notice that there were 10.4 gal. less on board than there should have been. And again, assume this continues for a 20 hr. flight; then the discrepancy becomes 208 gal. That is appreciable! Any time I'm flying 20 hr. and 208 gal. disappear, I want to know the reason why so it won't happen again. (See fuel-weight error curves in Fig. 1.)

In the original testing of an airplane-engine combination, one of the important tests is that of determining the fuel flows. In running a fuel-flow test, the engine operating conditions must be kept constant at all times, altitude must be held carefully, and fuel flow measured accurately. One means of measuring fuel flow is by means of Bowser gages. Normally, the large aircraft's tank quantity gages won't permit accurate enough readings for this type of testing because altitude greatly influences calibration. So we resort to Bowsers which read gallons, or to actual fuel flow rate gages calibrated in pounds. Pound gages however are of fairly recent vintage.

Results of these consumption runs were plotted as "fuel used" against hours for the various engine operating conditions, with altitude thrown in for good measure. And these curves were once plotted in gallons only. The peculiar thing about this was that the curve, as plotted in gallons only, was accurate when the fuel in the tanks was actually the same weight as when the aircraft was tested. In colder temperatures the gallon consumption would apparently be less, in hotter temperatures it would be considerably more.

Because it was realized that there were uncontrollable inaccuracies that crept into performance figures, these discrepancies were explained away under the guise of humidity effects, cooling errors, etc. Actually the difference wasn't too pronounced as long as the fuel loads were not large and the temperatures not extreme.

Longer range and bigger aircraft have demanded a revised technique. Let us accurately measure our fuel

FUEL LOADING REPORT

I. FUEL REQUIRED:
Gasoline _____ Lb.
Oil _____ Gal. (25:1)
Signed _____ Dispatcher

II. TO FLIGHT CONTROL OFFICE:
Fuel on Board Prior to Landing
Left Tank _____ Gal. _____ Dens.* _____ Lb.
Right Tank _____ Gal. _____ Dens. _____ Lb.
Hull Tank _____ Gal. _____ Dens. _____ Lb.
Total _____ Gal. _____ Lb.
Fuel Required _____ Lb.
Fuel Aboard _____ Lb.
To Be Loaded _____ Lb. @ _____ Dens.**

III. FUEL LOADED ON AIRCRAFT:
Left Tank _____ Gal. _____ Dens.** _____ Lb.
Right Tank _____ Gal. _____ Dens. _____ Lb.
Hull Tank _____ Gal. _____ Dens. _____ Lb.
Total Loaded _____ Gal. _____ Lb.

IV. TOTAL FUEL ON BOARD FOR DEPARTURE:
_____ Gal. _____ Lb.
Signed _____ Station Mechanic

NOTE: * Lb./Gal., Wt. of Fuel in Aircraft Tanks
** Lb./Gal., Wt. of Fuel in Storage Tanks

Fig. 4. Airport fuel-control form used by flight control and station mechanic to arrive at total load.

temperature during the testing with a thermocouple placed between the fuel pump and the carburetor. If this is impractical, we must make sure we measure the weight of the fuel as it is loaded prior to the test. Upon returning after the test, we can again measure it and convert our gallon figures to pounds by using a mean value. This system, although not as precise and technical as the former method, causes less trouble, and the difference is not appreciable. Discrepancies that creep in by using a mean value can be considered protected by more uncontrollable errors.

With our fuel readings in pounds, we can now be sure of maximum accuracy, provided we read the fuel

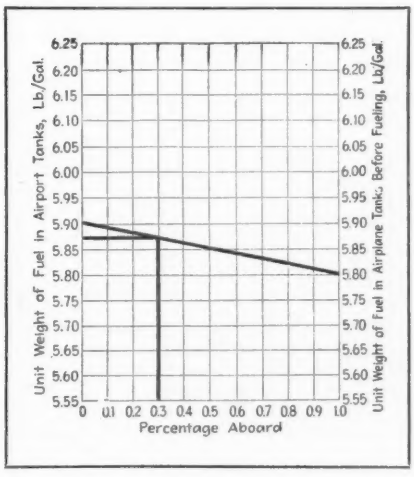

Fig. 5. Diagram for finding percentage of fuel loaded when unit weights are known

density on every occasion that we fill the tank. Of course, unless the fuel load is large, the payload paramount, and long-range flight contemplated, this procedure is not really worth while. For example, our curves show for a 20 hr. flight, at 1,000 ft. altitude we must load 20,000 lb. of fuel, including reserve. If we aren't that interested, we assume that the stuff weighs 6 lb. and the weather is warm, then order the man to put in 20,000 lb. or 3,335 gal. of fuel. But if we are extremely careful, we will insist upon a hydrometer reading, find out that our fuel weighs 5.73 lb. per gal. lon, and ask the man to put in 3,490 gal.

In the first case, when we arrive at our destination (even though we have followed the flight plan explicitly) we will have gone 155 gal. into the reserve, and as a result will probably complain that the fuel curves are inaccurate.

Curves *A*, *B*, and *C* of Fig. 2 show the variation of fuel weight with temperature for several common 100 octane fuels. Because specific weights for the same octane ratings and same temperatures will vary among fuel manufacturers, a temperature-fuel curve will not solve the problem unless you are very sure you will always be able to use the same fuel. To be on the safe side an actual hydrometer reading should always be made.

The adverse balance effects in a flight in which fuel-weight computation has been neglected vary with the type of aircraft. Size and location of the fuel tanks in relation to the center of gravity are the determining factors. All load adjustors are normally calibrated in pounds for the fuel load entry. If fuel curves are in gallons and you make the same assumptions as in the first example given above, i.e., 6 lb./gal., you will find that instead of having 20,000 lb. aboard you have, accurately, only 19,100 lb. That 900 lb. is going to make the takeoff gross weight inaccurate no matter how you look at it, or no matter what the weight manifest shows.

And, if your tanks are not pretty

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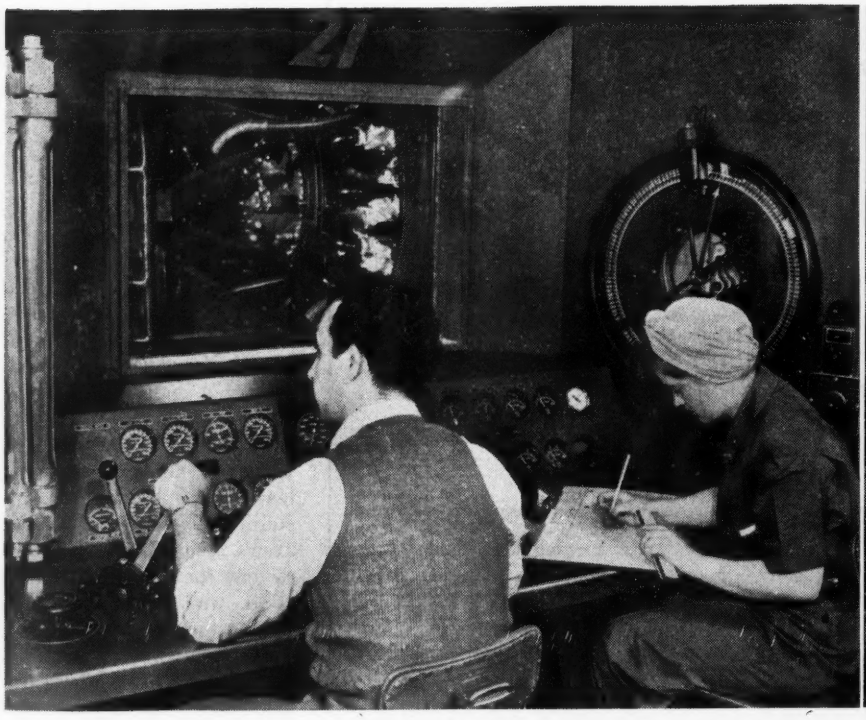
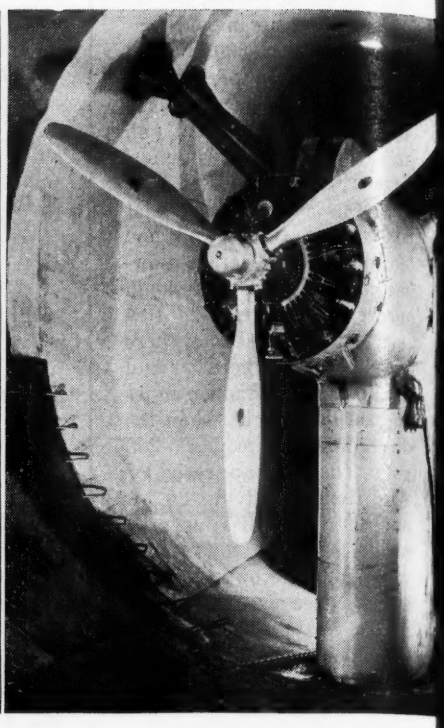




Engine test cell. Left: Protected by triple glass, operators record test figures as automatic controls run engine at predetermined setting. **Right: Prop house** where engine is run by remote automatic control. Sound absorber is at rear.

Test Cells Key Engines For Full-Power Performance

Saving both engines and man-hours, new automatic cells determine that power plants are "right"—assuring dependable operation on the battlefronts . . . . Described are installation, procedure, and the eight types of cells.

AIRCRAFT ENGINES DIFFER from most others in that they have to run at full power as soon as they are put to work. There is no easy "running in" period such as an automobile engine gets from its owner when new. Once warmed up, an airplane engine must give full takeoff power.

Because of this condition the engine must be thoroughly tested and ready for operation before it is installed in the airplane. This holds good for overhauled engines as well as for new ones.

Testing and breaking-in of aircraft engines is no simple matter of running them on test blocks a few hours to wear in the bearings. Instead, it is a long and complicated task—so complicated that until recently only skilled engineers were competent to handle the job.

The vast war-engendered expansion of production of engine plants, coupled with a shortage of skilled help, threatened to bottleneck the entire program.

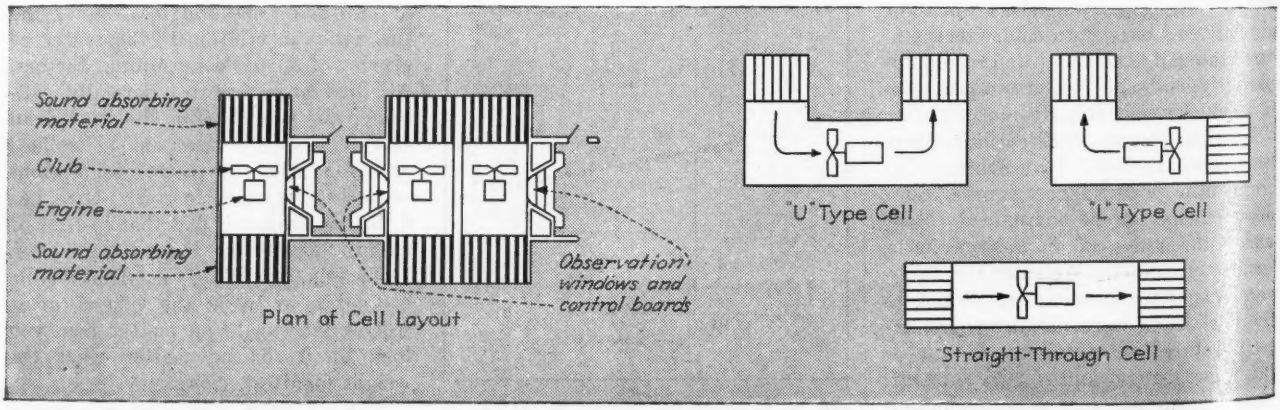
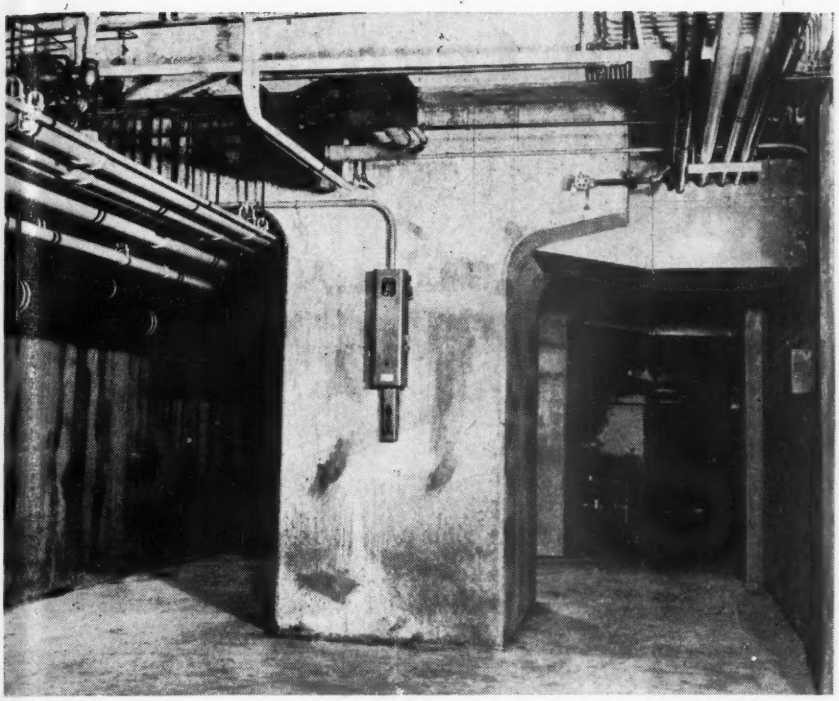


Diagram showing various types of test cell designs.



Tunnel under test cells contains piping for oil, coolant, compressed air, and three kinds of fuel. Cement pillar supports engine.

After the "ball got rolling," powerful aircraft power plants began coming off the lines in a volume ample enough to meet all scheduled needs, but the engines threatened to pile up at the end of the lines for lack of testing facilities.

Today, in plants dotting the country, more than 600 test cells of an entirely new design are helping speed production and testing. Differing widely from the older type, the new cells permit full control of the engine by only one test engineer and an assistant, and these cells give accurate control and recordings during the entire sequence.

Except for the armed forces' requirement (necessary in wartime) that certain data forms be filled out, the actual testing of an engine could be handled by one man. But after victory it is quite probable that such testing will be a routine job for a single individual, competent to manage the task after a few weeks of training.

Although the manpower consideration is important, it is not prime a matter as accurate and safe control permitted under the new automatic testing procedure.

Evolutionary, rather than revolutionary, the new method is largely the result of the tremendous demand for engines which developed immediately prior to the war. Although simple in operation, the equipment is extremely complicated. The motor to be tested is mounted on a special block and enclosed in a cell, which actually is a small room. Fuel lines, oil lines, air ducts, throttle controls, temperature and pressure indicators, and a maze of wires and tubes necessary to start and control the engine, are attached to permanent connections within the cell.

These connections are remotely controlled by recently developed and specially designed switches, controllers, motors, dampers, and valves so that a test engineer may sit outside the cell

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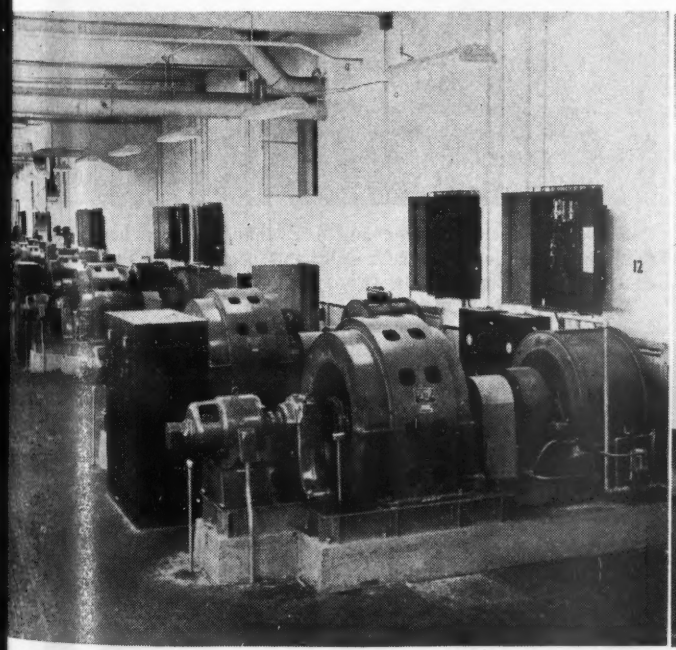
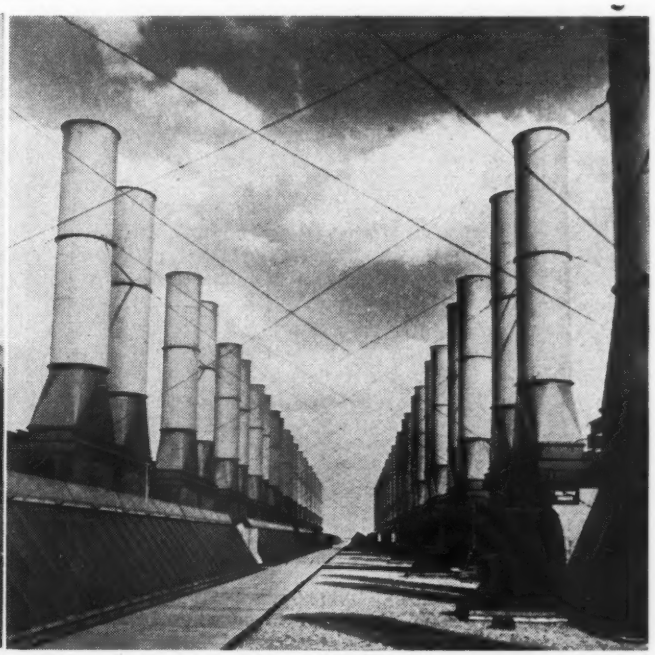


Electric generators provide means for readily varying load and for returning most of aircraft engine power in form of electric current.



Exhaust stacks carry away gases from test cells. Noise is eliminated by using sound-absorbing chambers (as seen above) at bases of the stacks.

Northrop Contributions To Maintenance

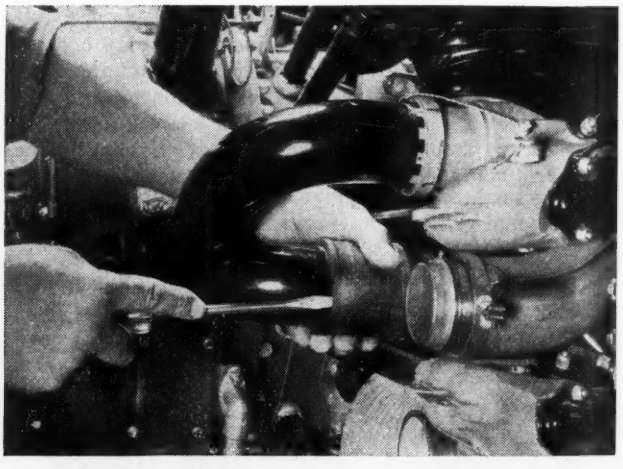
Higbee's hose removing tool. It prevents much damage to intake manifold hose connections.

Northrop's New Hose-Handling Tool

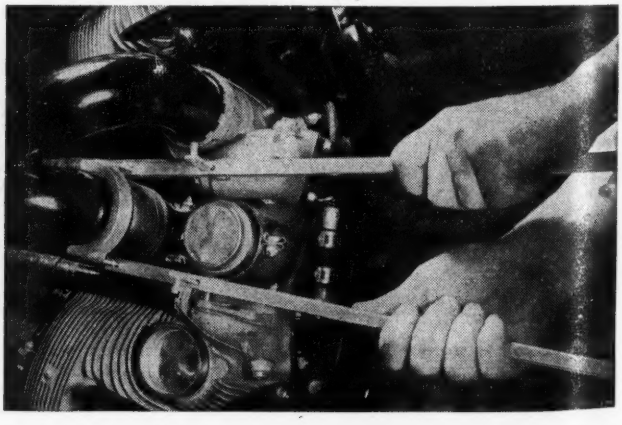
• Bill Higbee, mechanic in Northrop's engine installation department, invented special tool, depicted here, for handling 3-in. manifold-connection hose. With old screwdriver method there were many damaged hoses and scarred manifolds, and in addition much time was lost. Higbee's device, however, exerts a steady end pressure on the hose, and job is done quickly. There is no chance of damage either to hose or manifold. This tool consists of a flanged collar fitting end of hose, connecting levers on sides of collar, and dogs hinged to levers in such manner that they engage holes on cylinder head flanges nearest to connection.

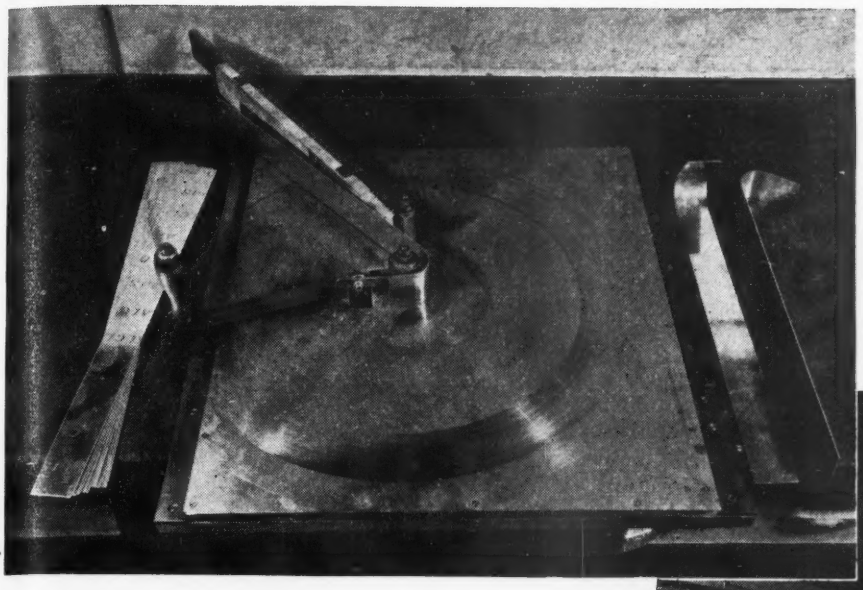
Bill Higbee at work with his device in Northrop engine installation department.

Right: Tool replacing hose connection. Note ample leverage through long handles. To remove hose, tool is reversed and pressure is applied in opposite direction.



Old method—screw driver and bare hands. Torn hoses and scarred manifolds were the result, and occasionally there were accidents to worker's hands. (Photos courtesy Northrop Aircraft.)





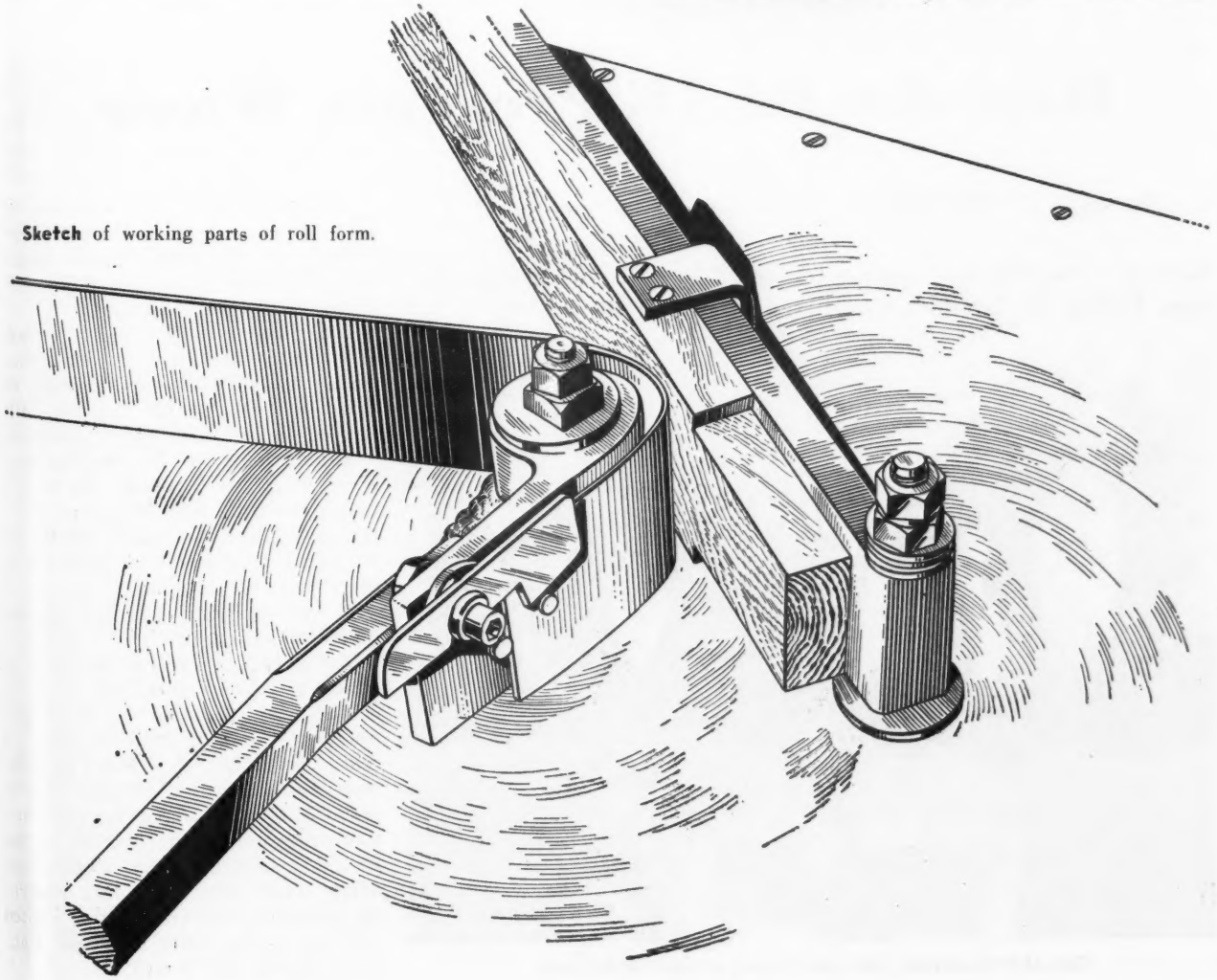
Latest model of machine, showing finished work at right, unworked material at left.

Robert York with an early model of hand-operated roll form which brought him WPB award. (Photos by Northrop.)

Hand Operated Roll Form

• Robert York, of Northrop's sheet metal department, invented this machine to perform in one operation work which formerly required several handlings. Straight stock, such as seen at left of machine, is placed in unit and held by small screw clamp. Handle is then rotated to bend metal, radius of bend being determined by distance of wooden bar from center on which bending arm rotates.

Sketch of working parts of roll form.

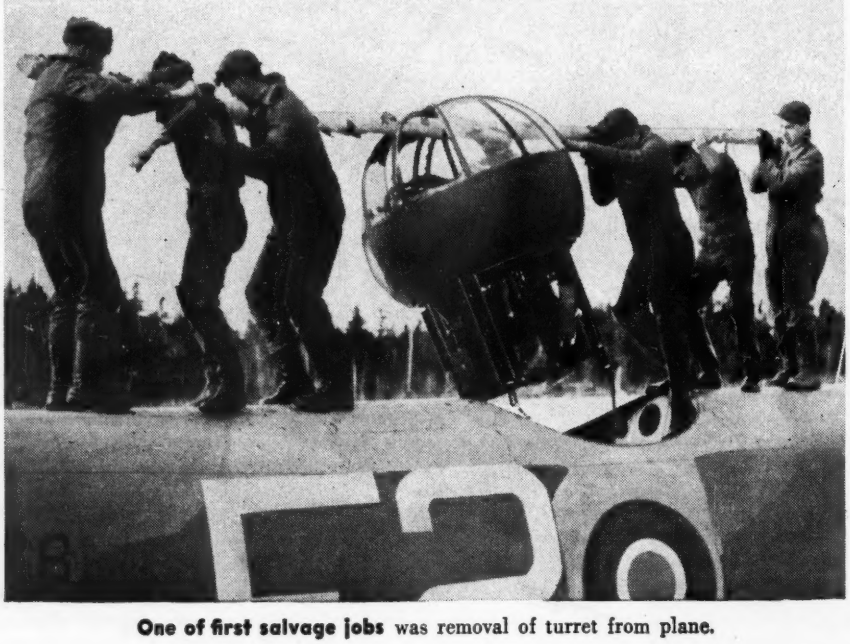


"Ventura" bomber sunk through ice. Partly stripped to save weight, plane is supported by 56 ft. trees sunk in 23 ft. of water. Later it was floated to shore through channel sawed out of ice.

How the RCAF Prevents Waste

By **JAMES MONTAGNES,** *"Aviation's" Canadian Correspondent*

Nothing is too big and nothing too small to be saved and put to some further use by the salvage department of the RCAF.

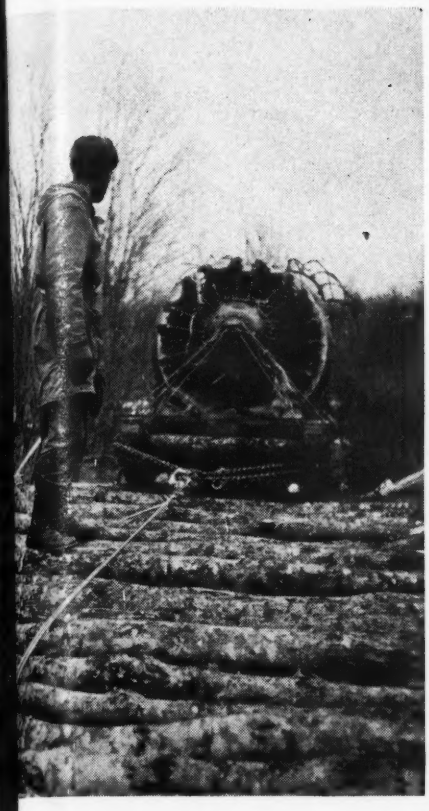


One of first salvage jobs was removal of turret from plane.

SALVAGE, RE-USE, AND DISPOSAL of equipment, from uniforms to aircraft parts, is a feature in the operations of every Royal Canadian Air Force base in the Dominion.

True enough, for the first two years of Canada's war there was little time for the RCAF to consider salvage. In those days the RCAF had too little equipment and was too busy procuring it and building up the vast training organization which is today the British Commonwealth Air Training Plan. But in the past two years, the RCAF has begun to make all possible use of every item of equipment, in accord with conservation measures of the Canadian government.

Today that system is working so efficiently that before any item of equipment is disposed of as scrap—whether a pair of uniform pants, a radio transmitter, or a sheet of perspex from a salvaged aircraft—it will first have been offered for reclamation or re-use to all branches of the RCAF, Canadian Army, Royal Canadian Navy, other Canadian government departments, and to other United Nations governments through Canada's Mutual Aid Board.



Engines were skidded over corduroy roads to the repair base.

Typical of the study which is given all salvageable material is the case of broken plastic window glass. RCAF dental officers found that perspex which had no more aircraft use could be formed into splints and headcaps necessary in plastic surgery to hold broken jaws. Further, engine packing cases are re-used for shipping between RCAF depots, or they are offered to the engine manufacturer.

Extent of the salvage operations was first publicly revealed this summer when the Parliamentary Public Accounts Committee questioned the RCAF on its salvage work and savings made to the taxpayers through its operations. At that time, a financial report given to the committee showed that in the year from June 1, 1942 to May 31, 1943, there was sold to private companies or transferred to other departments equipment totalling over $1,000,000 in value. Ranging from aluminum to scrap rubber, and from spark plugs to X-ray film, this covered anything and everything which the air force itself could not re-use.

Salvage operations are varied, some being small, some big. The program is a daily routine at training stations. There are also special operations. One such was the RCAF's salvage, on the Atlantic coast command last spring, of a twin-engined *Ventura* bomber, worth $250,000. It soon was flying again.

It was during the beginning of the spring thaw that this *Ventura*, with its crew of five men, went out on patrol from a Nova Scotia base. Engine trouble and bad weather conditions forced the plane down on a lake. The pilot brought the bomber down on the melting ice without mishap to ship or crew. Then the radio brought a ski-equipped plane which took the crew off.

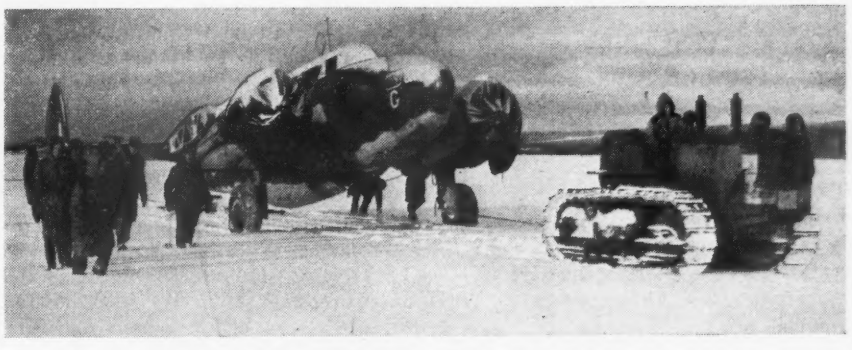
But to bring the bomber out was another problem. There was no road directly to the lake, the nearest one being 14 mi. distant. The Canadian Army was called on to help, and along with an RCAF crew it hewed a road out from the lake through virgin bush. Meanwhile to save the aircraft from sinking through the melting ice into 23 ft. of water, the rescue crew cut down trees and hauled them through the woods for three-quarters of a mile without the aid of a tractor. Holes were cut in the ice and the trees sunk to the lake bottom. The bomber was next strapped to the poles, then floating

wooden platforms were built. It took half a day to sink the first pole, and it was two days before the second was secure. One and a half miles of rope were needed for guying purposes.

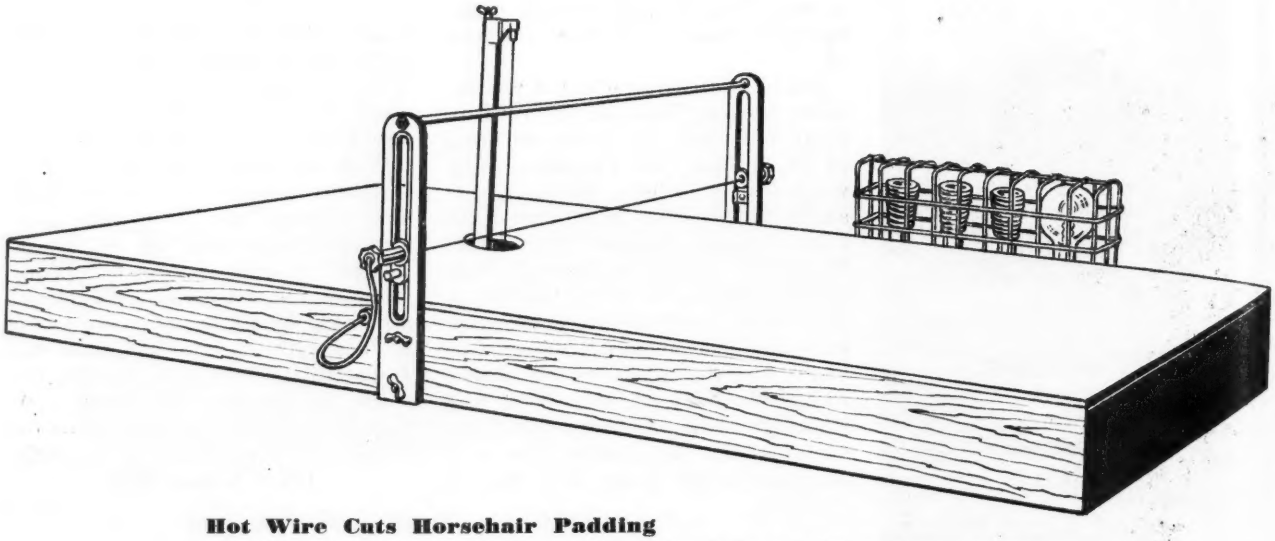
With the aircraft secure, the work of taking it apart was started. First item salvaged was the machine gun, then the gun turret, then the wings, followed by the engines. Everything was placed on wooden sleds and hauled across the ice to the camp site at the lake edge. By the time the plane was dismantled and the road finished, five weeks had passed. The salvage crew took the parts out by truck, while the aircraft itself was attached to a bull-

(*Turn to page* 324)

After craft was floated ashore it was hauled by bulldozer 14 mi. over bush roads specially cut for that purpose.

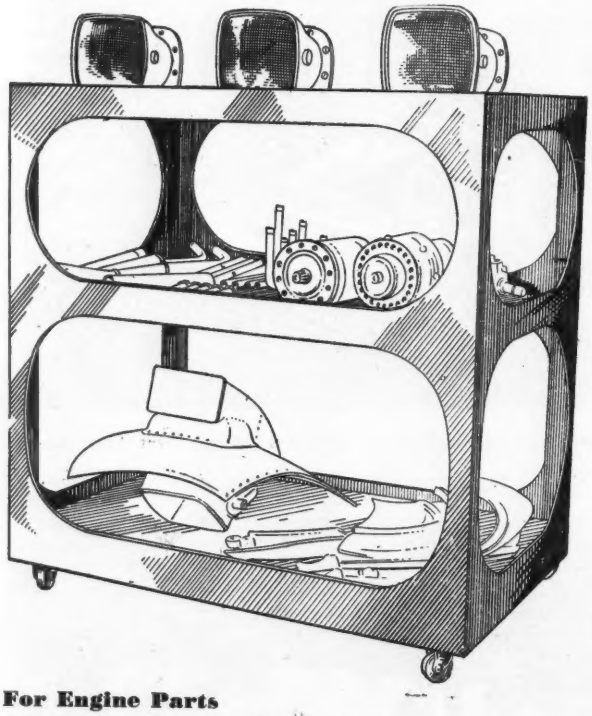


Downed "Hudson" bomber gets tractor tow. It will quickly be back in service.



Hot Wire Cuts Horsehair Padding

• Rubberized horsehair cushion padding is tough for a knife or shears, so Pan American's Miami maintenance base built this device with electrically heated wires which cut smoothly through material. Upright wire at left makes vertical cuts.



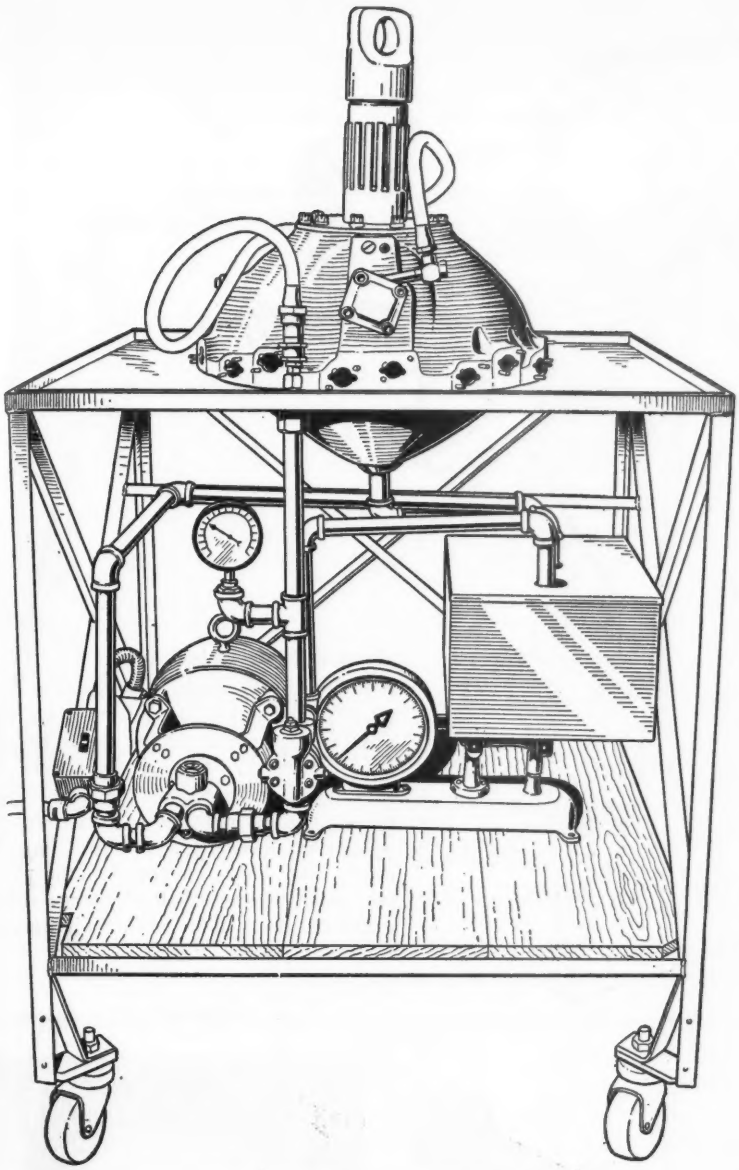
For Engine Parts

• Using minimum of critical materials, PAA constructed this engine parts stand of plywood. Single sheet construction of sides gives stand rigidity.

Portable Small Parts Receptacle

• PAA uses this rolling stand for transportation and classifying small parts in shops. End door permits loading of long parts which would not conveniently fit into upper portion.

AVIATION'S MAINTENANCE NOTEBOOK

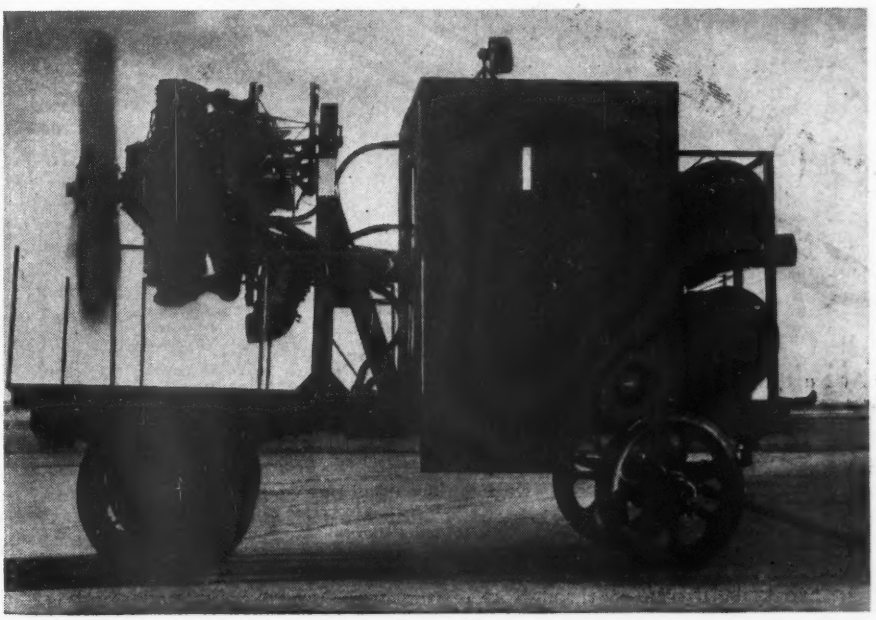


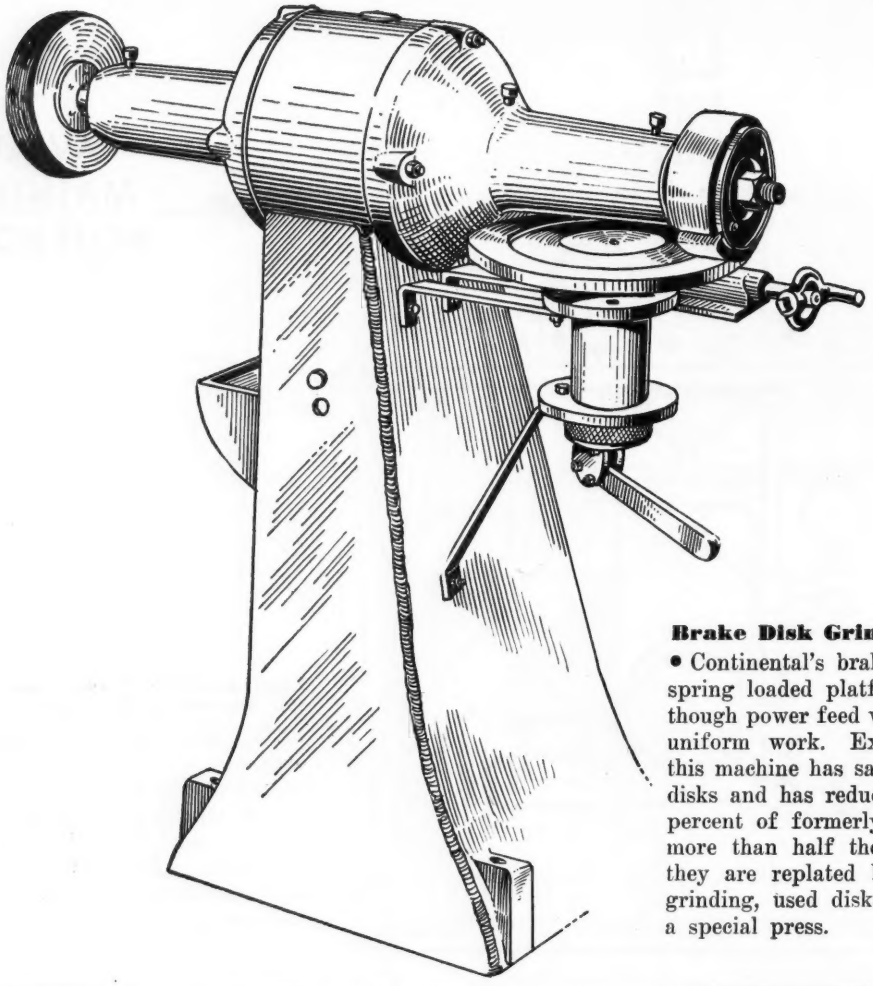
Continental's Nose-Case Oil Pressure Checker

• TWA developed this fixture for determining oil pressure maintained in nose section of G-202A engines. This enables checking of functioning of oil seals in nose section before engine is assembled and test run. Fixture has saved considerable amount of time in test service work.

Portable Test Stand

• This new engine test stand, designed for Wright engines, has been completed by Continental Air Lines' maintenance department and is now in service, primarily for Army cargo equipment. Mounted on old hard-tire truck chassis, test stand enables run-in tests on engines as quickly as they come from shop after major overhaul. Stand was designed by Edwin L. Durham, engine overhaul foreman, and was built by F. R. Richey, mechanic-welder, and J. M. Johnson, carpenter.





Brake Disk Grinder

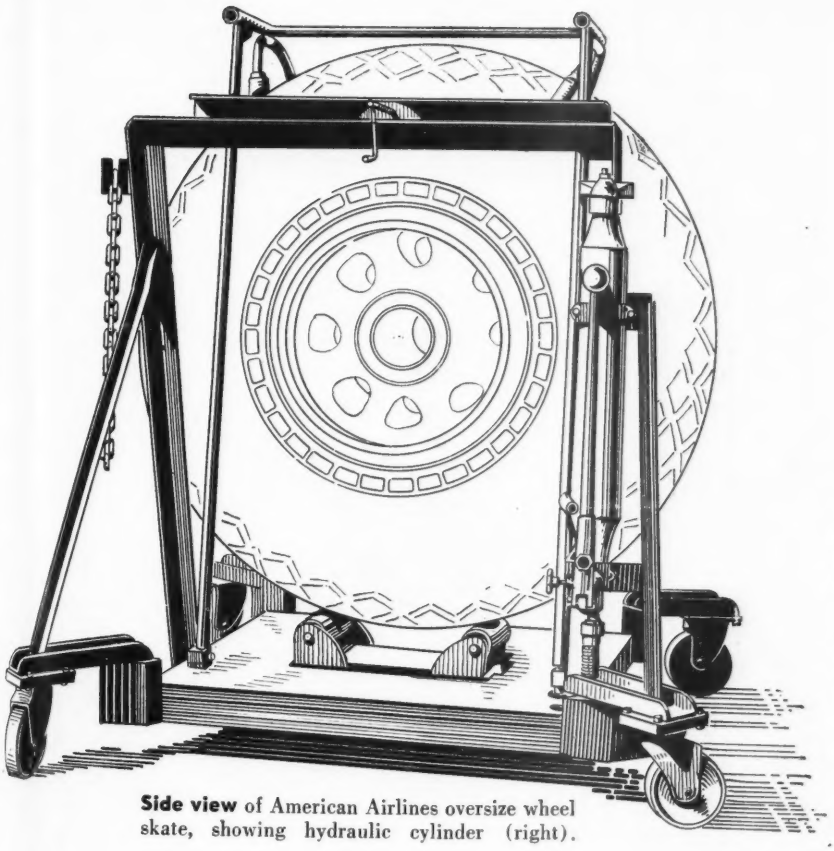
• Continental's brake disk grinder has a spring loaded platform turned by hand, though power feed will be added for more uniform work. Experience shows that this machine has saved 97 percent of all disks and has reduced costs to about 50 percent of formerly. If disks have lost more than half their chromium plating they are replated before using. Before grinding, used disks are straightened in a special press.

Threaded Drift Pin

• At Northrop, Ray Steele, leadman in final assembly, submitted to war production drive committee a tool which found use throughout plant. In many cases while aligning holes which were blocked at one end, ordinary drift punches "seized," presenting a serious removal problem. If punch snapped off, it had to be driven on through at expense of fine tolerances; if twisted out without breaking, holes were damaged and required reworking with files.

Failing to find a suitable tool, Steele developed one of his own consisting of a threaded drift pin of design applicable to various sizes. Pin is threaded approximately one third of distance from head toward point, and a nut is run on threaded portion of shank. A collar fits over tapered end of pin and stops against nut.

In operation, collar is slipped on and pin driven into hole to be aligned. Once job is accomplished, nut is screwed down against collar, which is forced against edges of hole. Pin is withdrawn without any damage.



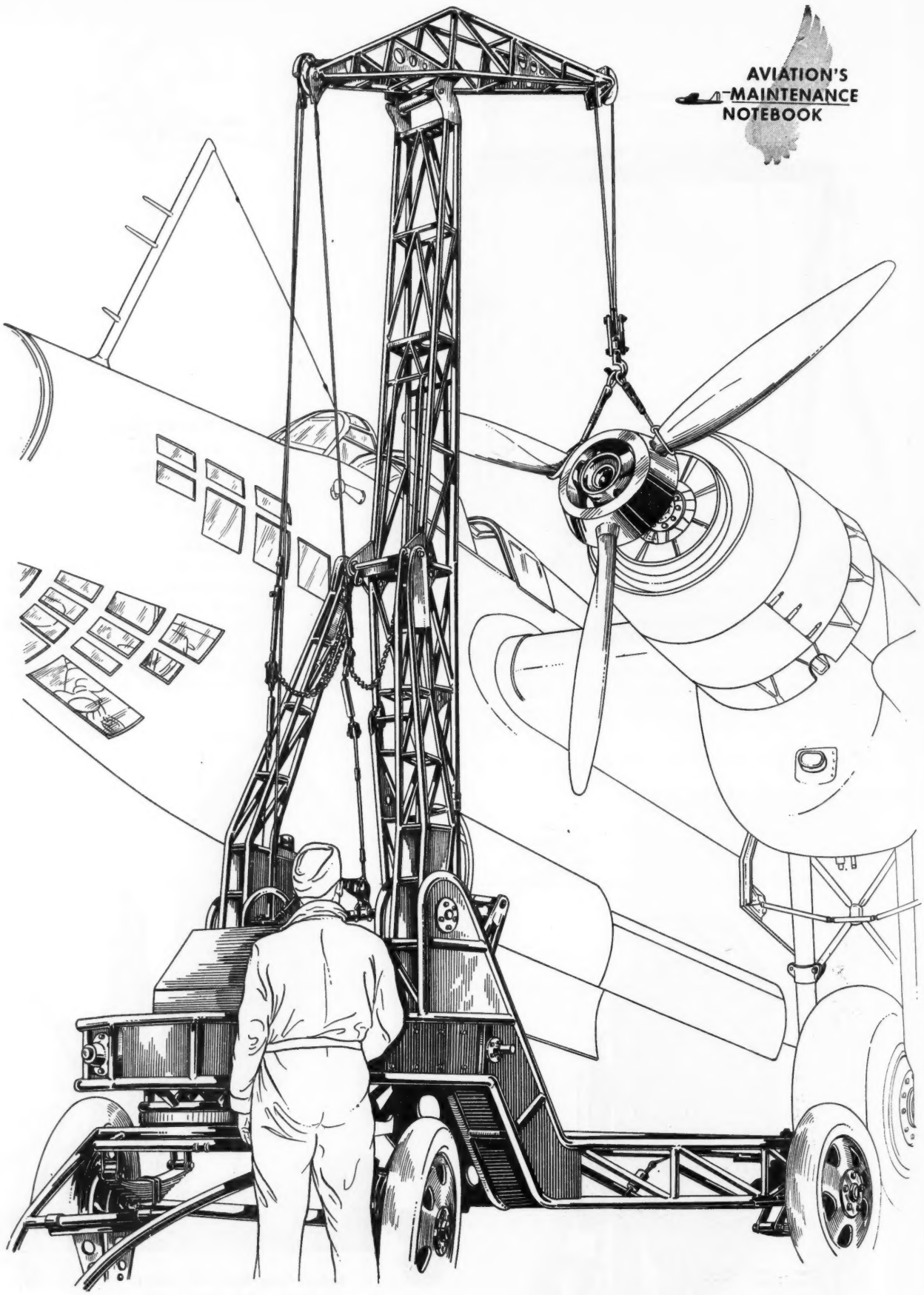
Side view of American Airlines oversize wheel skate, showing hydraulic cylinder (right).

Oversize Wheel Skate

• Luther Mead of American Airlines devised machine, illustrated here, for handling huge transport tires when they are changed. Formerly this operation required six men on three 8-hr. shifts, but now two men can change both tires in an hour. Machine consists of low-slung platform fitted with hand crank at top of side rail and hydraulic pump at side. By these means, operator can raise or lower wheel and move it in or out as required, without exertion and in less time.

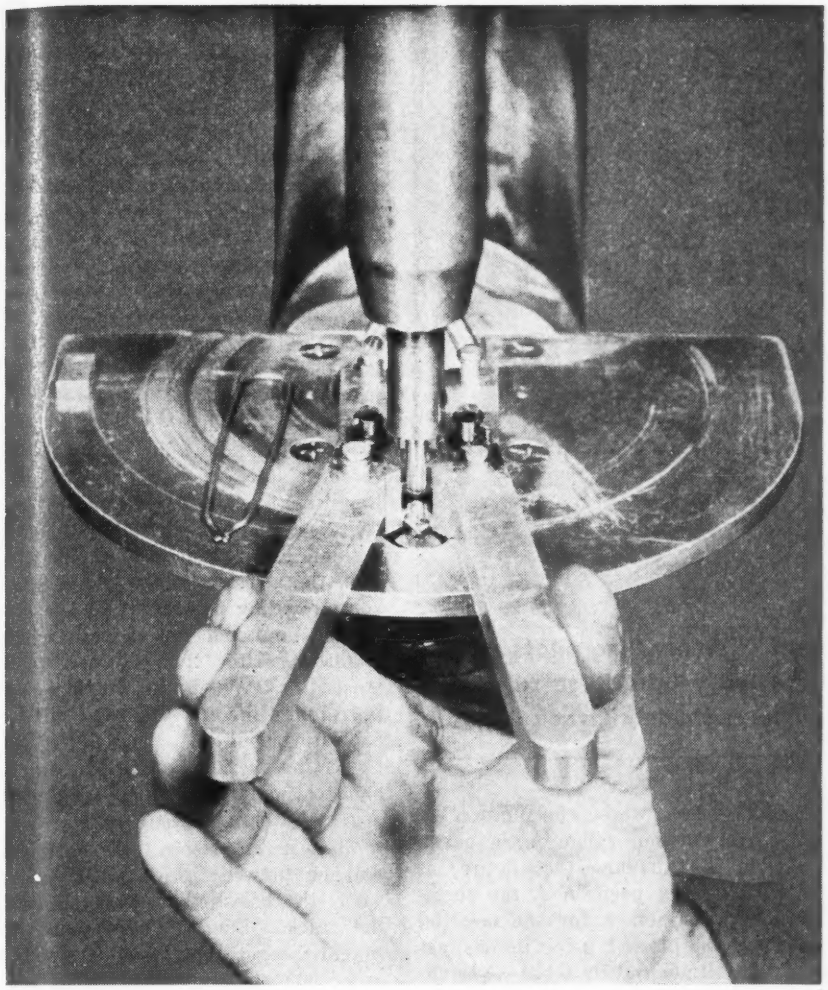
Wheel skate in down position, wheel vertical.

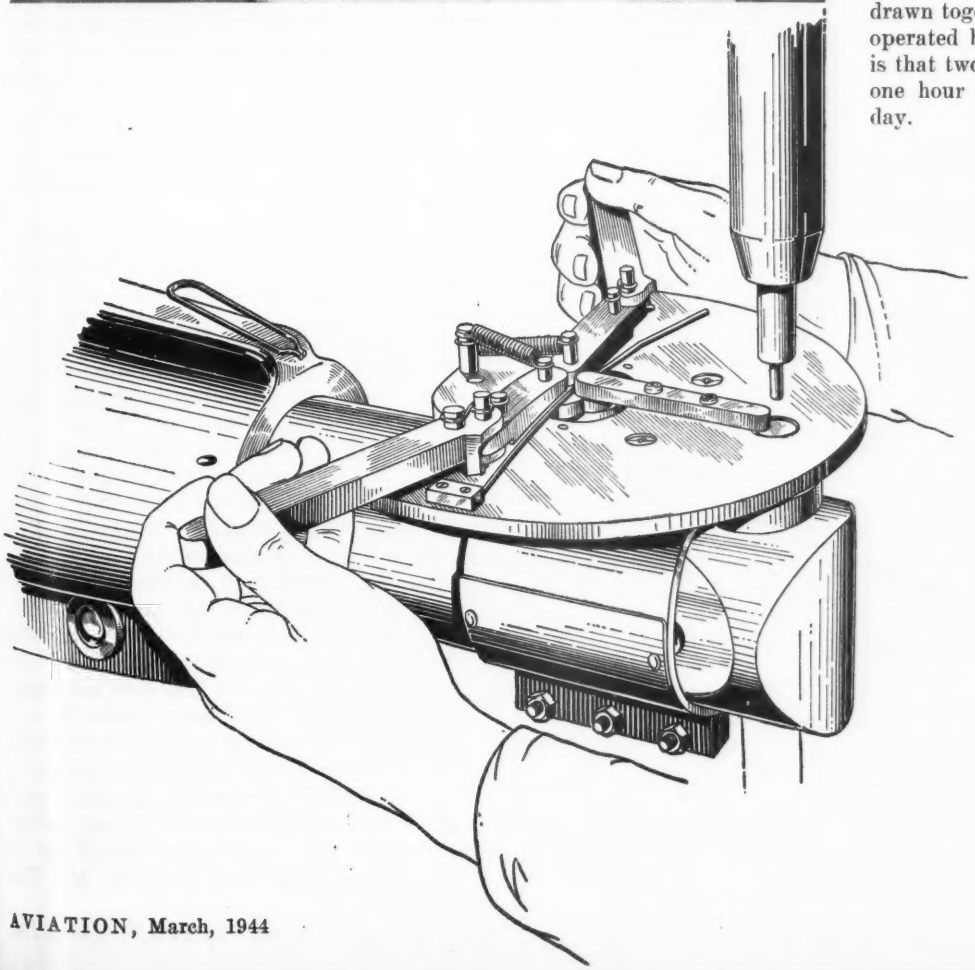
Raised position with wheel tilted outward by hand crank.



Soviet Air Force Builds Own Crane
(From Russian Sources)

• This extension crane, apparently built from whatever materials were at hand, has undercarriage fitted with horse shafts, and extensive upright and tilting top arm are from tubing, welded into strong, light structures. Top tilts to give final close adjustment.





Welder Attachment For Hose Clamps

• Boeing has saved over 95 percent working time on this operation by the use of the device here illustrated. The straps, used to secure hose and tubes on B-17's were formerly cut from stainless steel wire and then flash welded together. As cutting left the ends too irregular for welding they had to be ground until they met squarely, but in spite of this, rejections ran over five percent.

The problem was put up to Leon Mooradian, then assistant chief research engineer, who decided that spot welding would be more satisfactory than flash welding. The result was the attachment shown here. The cut wire is inserted until it touches the stop block at the left. The arms are then drawn together by hand and the welder operated by foot pressure. The result is that two persons now do as much in one hour as six did formerly in one day.

Graphic Solutions to Celestial Avigation

By CAPT. JAMES B. REA
Pan American Airways

Flying "up where the sun always shines," sea-hurdling pilots readily "target" the most minute of islands lying on the huge ocean expanses below them—by using these key methods of track location.

EVERY AVIGATOR should be able to determine quickly during flight the GCT's when a celestial body will be on his meridian, when it will be abeam of his track, and when it will be on his track. The first will give him an accurate latitude check, the second a track check, and the third a ground-speed check. These three positions are very important to the avigator during daylight flight, when visible celestial bodies are very few.

This article presents a quick graphical solution for determining the GCT's for these three pertinent positions.

As an example, let us assume we are on a track between Honolulu and San Francisco, as shown in Fig. 1—and to make it simple, let us assume that we want to determine the GCT's for these three critical positions of a celestial body whose declination is within the latitude range of the chart.

When the airplane (see figure) is in an arbitrary position *1*, the corresponding position *1* for the celestial body may be plotted, using its declination as latitude and its GHA as longitude, as determined quickly from the *Air Almanac*. In the same way, positions *2* for the airplane and the celestial body may be plotted if the ground-speed of the airplane is known. The following construction is very simple: Point *2'* is located by drawing a latitude line through position *1*, and a longitude line through position *2*. Then lines *1-1* and *2-2'* are drawn, and their intersection at *H* locates the true hub. Now, if a longitude line is drawn through point *H* it will intersect the airplane's track line and the celestial body's declination line, as shown by the points marked *M*. The GCT for the celestial body when it is on the meridian is now easily obtained from the *Air Almanac*, using the GHA as indicated by the point *M* on the declination line. Or it may be determined by calculating the GCT when the airplane will arrive at point *M* on the track line, using the known ground-speed and the distance *1-M*.

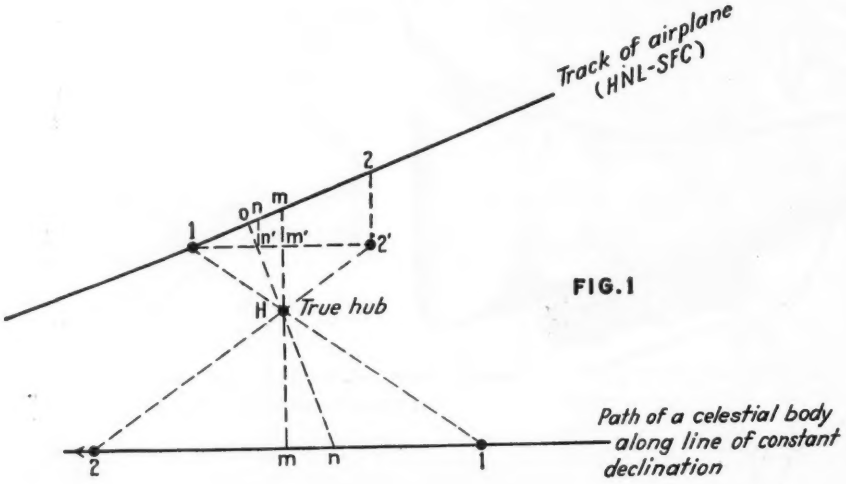


FIG. 1

Once the true hub, *H*, has been determined, the GCT for the celestial body when it is abeam of the track is found as follows: Draw the line *N-O* perpendicular to the track and through the true hub. This line will intersect the line *1-2'* at *N'*, and a longitude line through *N'* will intersect the track line at point *N*. When the airplane is in position *N* on the track line, the celestial body will be at the corresponding position *N* on the declination line, and its azimuth will be slightly greater than 90 deg. to the track line. When the airplane is in position *O*, the celestial body will have a position slightly to the right of position *N* on the declination line and the azimuth will be slightly less than 90 deg. to the track line.

Thus, it can be seen that the airplane will be between positions *O* and *N* when the celestial body is abeam of the track. Usually these points are so close together that no appreciable error is made by using the GCT for the airplane (in a position half-way between these two points) as the GCT for the celestial body when it is abeam of the track. If further accuracy is desired, the exact position may be obtained by trying points between *O* and *N* until the azimuth is exactly 90 deg. to the track.

The GCT for the celestial body when it is on the track is found as follows: Assume that the airplane remains at position *M* on the track. Using the latitude of position *M* and the declination of the celestial body, determine (by using the HO-214 tables) the local hour angle of the body when its azimuth is equal to the track direction, or 180 deg. plus the track direction, depending on whether the body will be on the track ahead of or behind the airplane. Convert the local hour angle thus determined to time (15 deg.=1 hr.), and apply this time to the GCT at point *M* to get the GCT for the celestial body when it is on the track. The fact that the airplane does not remain at position *M* does not affect the solution appreciably because the airplane's track is along the desired azimuth.

Actually, there will be a very small (and negligible) error due to the fact that the airplane has moved up the track away from position *M*. This

error can be easily understood when it is remembered that the plane (determined by the airplane's position, the celestial body's actual position in the sky, and the body's sub-astral point) intersects the earth's surface in a curved line when represented on a mercator chart. The HO-214 tables show this fact when it is noticed that the azimuth of a celestial body whose declination is equal to the observer's latitude is a function of the local hour angle.

It should be noticed that the determination of the line *M-M* is independent of the body's declination. All hubs will lie on this line. This fact is clearly shown in Fig. 2.

In other words, Fig. 2 clearly indicates that the GCT for the celestial body when it is on the meridian is independent of its declination. Thus, the line *M-M* may easily be determined, even though the declination of the body is not within the latitude range of the chart. The bottom of the chart is convenient for locating points *1* and *2* for the body, since it is usually marked in degrees and minutes of longitude.

It should also be noticed that the true hub must be used when determining the GCT for the body when it is abeam of the track. The true hub is the hub obtained when points *1* and *2* are actually on the body's declination line. In other words, the GCT for a celestial body when it is abeam of the track is a function of its declination as well as its GHA.

When the body's declination is not within the latitude range of the chart, and it is required to find the GCT for the body when it is abeam of the track, then it is necessary to first locate the true hub on the line *M-M*. Referring to Fig. 3, the distance, X, that the true hub is below the line *1-2'* is found as follows:

Once the true hub has been determined on the line *M-M* by measuring a distance,

$$X = K\left(\frac{a}{b+a}\right)$$

below the line *1-2'* the GCT for the body when it is abeam of the track is easily found as shown in Fig. 1. The value *K* is dependent only on the latitude at position *1* and the body's declination.

Thus far, the constructions and proofs given have been only for a northeasterly track and for bodies whose declination lines are below the latitude of position *1*. Rather than explain the details for other analogous cases, the typical constructions will be as follows:

(*Turn to page* 339)

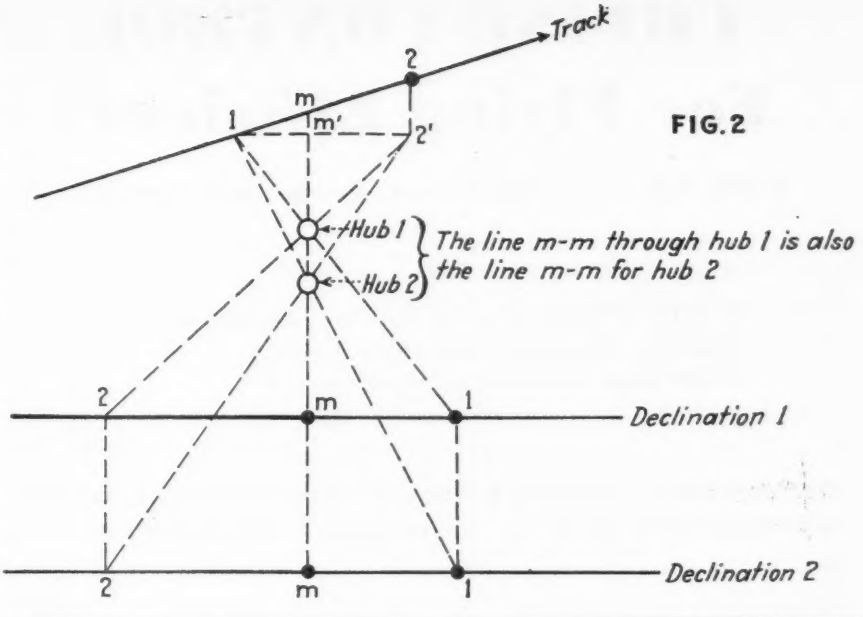
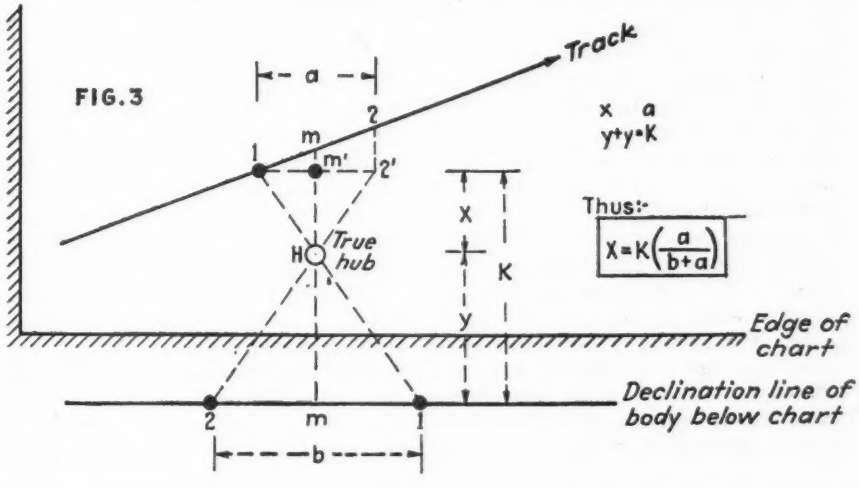
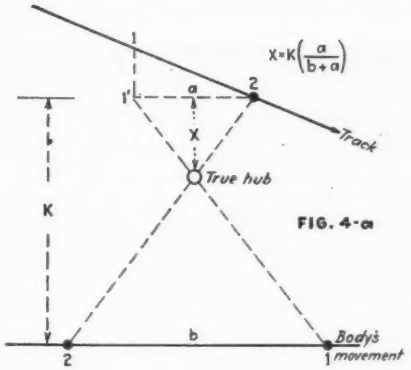
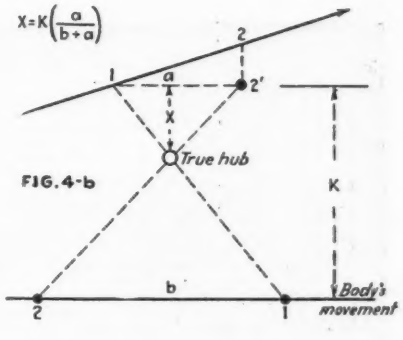
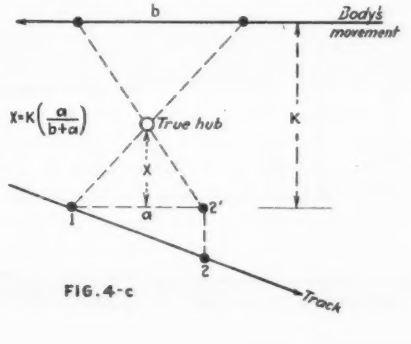


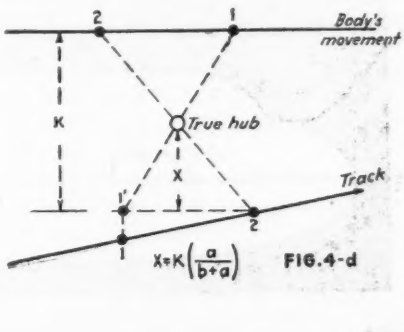
FIG. 2











CRUISE CONTROL For Flying Efficiency

Part VII . . . Maximum Range and Loading

By

DIXON SPEAS, *Asst. to Vice-Pres., Engineering,*
JERE T. FARAH, *Chief Flight Analyst,*
SANFORD HINTON, *Flight Analyst,*
American Airlines

Maximum range, load, and balance are here determined, and their importance with regard to efficient flight is demonstrated.

THERE ARE a seemingly endless number of considerations in the search for conditions which will produce an operable maximum range system of flight technique. Determination of these would be quite simple if several of the more elusive variables could be ignored—but in order to produce a rational analysis the effect of each factor must be surveyed.

Assume, for instance, an airplane operating at a given altitude, a given gross weight, encountering a given effective wind, having an engine operating at a certain specific fuel consumption, and a propeller of known efficiency. Under these conditions there is one—and only one—speed-power combination at which maximum range, or *most miles per pound* of fuel, is obtained.

But alas, we are presented with an airplane which continually changes its weight as flight progresses . . . we are required to fly at a great range of altitudes, encountering such effective winds as nature is capable of producing . . . and our engine and propeller, respectively, complicate the problem by introducing variable specific fuel consumption and propulsive efficiency.

Detailed analysis is the best hope for an accurate solution of the maximum range problem.

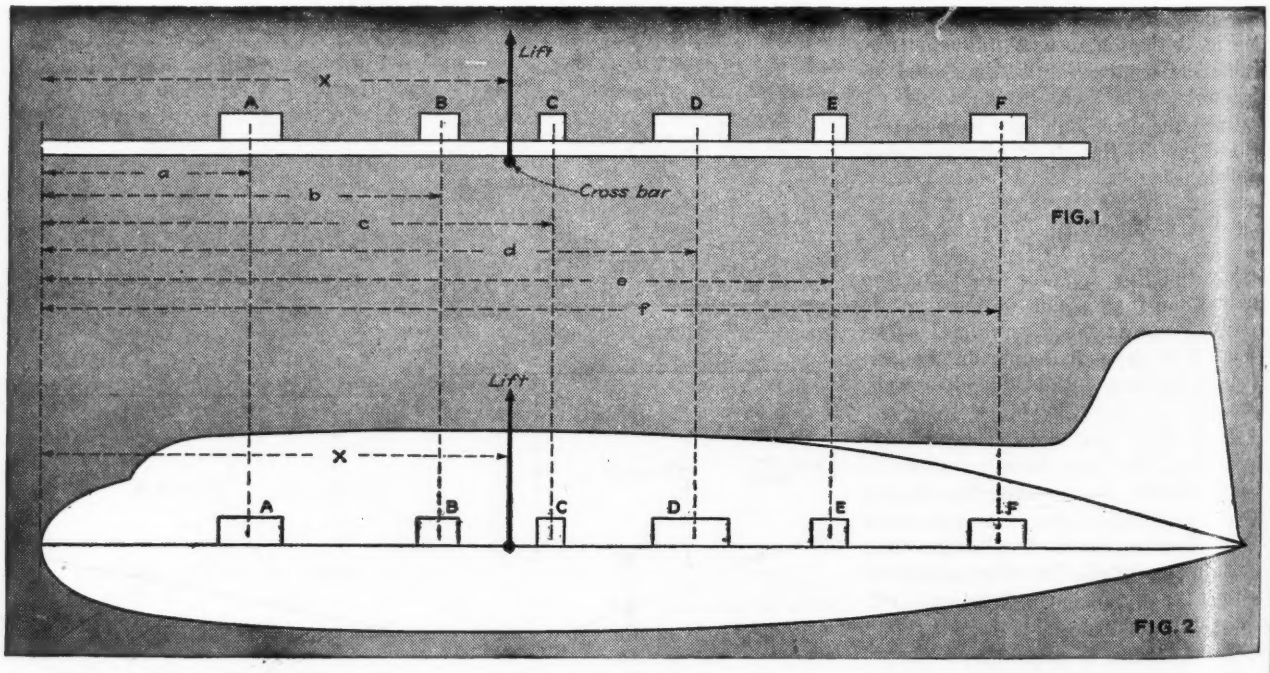
The initial information required consists of a basic curve of speed-power relationship, performance curves for the subject engines, and fuel consumption figures for all usable horsepower-engine-rpm. combinations. The speed-power curve may be of the "cruising horsepower chart" type, previously described, in which power is expressed as brake horsepower, which necessarily is based on average propulsive efficiencies, or of the type based on thrust horsepower.

If the latter is used, it will also be necessary to have available a chart of propeller efficiency. The *Cruising Horsepower Chart* is, of course, much simpler to use in maximum range analysis, since the power required for various speeds is read directly as brake horsepower, this being the basis of the engine performance and fuel consumption curves. Thrust horsepower speed curves are slightly more accurate for use in this type of analysis because propulsive efficiency is actually calculated at each speed investigated.

Before beginning the task of maximum range analysis, there will be limitations on the airplane and engine performance—to be recognized and kept in mind at all times. Among these are maximum allowable airspeeds, minimum airspeeds for controllability, maximum cruising power limits, objectionable engine rpm. ranges to be avoided, brake mean effective pressure limits on the engine, etc.

Basically the problem consists of determining the speeds for best range at a variety of airplane gross weights, altitudes, and effective winds. The required spread of each of these is then broken down into representative increments, and each of the combinations are considered separately.

Figs. 1 and 2. Combination diagram shows method of computing airplane balance loads.



For example, assume that a given airplane may vary in weight from 25,000 lb. to 17,000 during flight, will be flown between sea level and 20,000 ft. altitude, and may encounter winds of from 60 mph. tailwind to 60 mph. headwind. The weight spread may be adequately covered by analyzing for speeds to obtain maximum range at 25,000 lb., 23,000 lb., 21,000 lb., 19,000 lb. and 17,000 lb.

For altitudes, analysis at sea level, 5,000 ft., 10,000 ft., 15,000 ft., and 20,00 ft. should be satisfactory. Winds of —60 mph. (headwind minus), —40 mph., —20 mph., 0 wind, +20 mph. (tailwind), +40 mph., and +60 mph., gives wind speed range coverage.

Thus it is seen that a complete analysis of this type would be extremely lengthy if an accurate picture of the situation is to be obtained.

To proceed, it is now necessary to take each combination of the above conditions and select a spread of airspeeds which probably will "bracket" the best-range airspeed for that combination and determine the bhp. required for each speed of the range. This bhp. required is either selected directly off the *Cruising Horsepower Chart* or calculated from the speed-vs.-thrust-power curve considering propulsive efficiency.

After determining the power required for each speed of the spread of speeds, the fuel flow may be determined from a chart of specific fuel consumption vs. bhp., at various engine rpm. The engine rpm. must be one capable of producing the required power at the subject altitude, and also one which is safe from the bmep. standpoint. Having the fuel consumptions for the various speeds, the mi./lb. of fuel is computed for each speed by dividing the ground speed (true airspeed minus or plus effective wind) by the fuel consumption.

Plotting mi./lb. against airspeed, the curve will peak at some one airspeed for the combination of conditions analyzed. This is the maximum range airspeed for the particular set of conditions.

To complete the picture, each of the combinations of weight, altitude, and wind is to be studied in the foregoing manner. The method of presentation of the results of such an analysis is a highly debatable subject and no doubt the several methods in use at the present time can be improved considerably. However, the important fact is that for each given set of conditions, any airplane has one speed at which more miles may be flown per pound of fuel used than at any other.

Many objections are raised against the use of maximum range cruise control because of the slow speeds sometimes specified as best range airspeeds. These objections are justifiable in many cases when time conservation becomes predominant over fuel conservation, and for routine operation it is often possible to fly at higher speeds than those for maximum range to gain a time advantage which outweighs greatly a small saving in fuel consumption afforded by absolute maximum range.

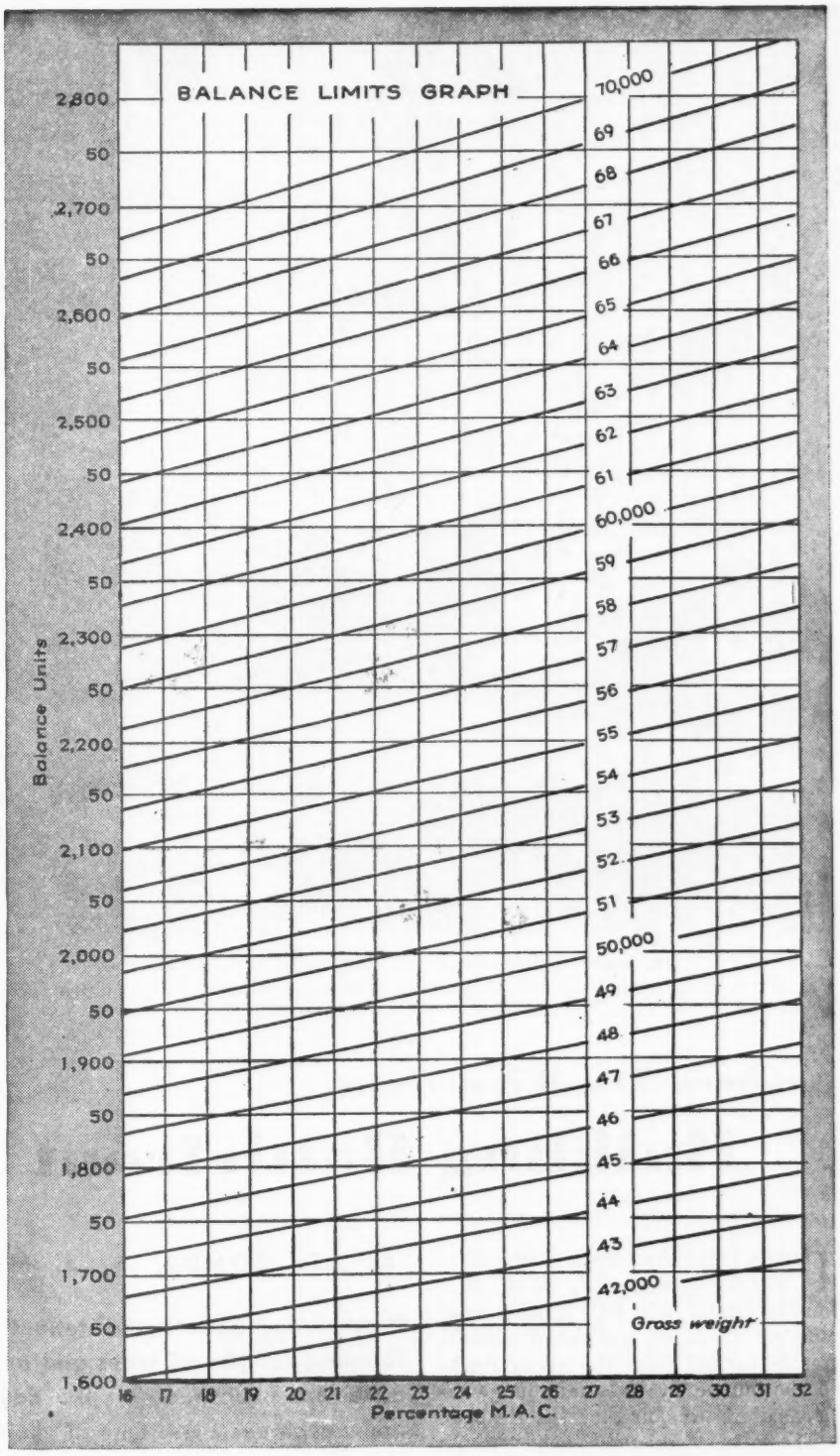


Fig. 3. Balance limits graph, giving percentage MAC against balance units.

However, when paramount importance is placed on getting absolutely the most miles per pound of fuel burned, maximum range is the one procedure which must be used, regardless of time or the "feel" of the airplane at maximum range airspeeds.

Since the speeds to be flown in obtaining best range depend upon airplane gross weight, it is important that the initial loading and running

(*Turn to page* 299)

This tract — believe it or not — will be an airfield. Knowing "a straight line is the shortest distance," a Seabee drives his bulldozer straight ahead through the palm trees. A strip will soon be carved out.

Seabees Are Wizards at

Building Battlefront Air Bases

By LT. COMDR. S. J. MATHIS, *Civil Engineer Corps, USNR*

Despite Jap bullets and defiant jungles, NCB men slash away the tortuous tangles of trees and undergrowth, lay out air strips—and have 'em smoothed "on the double" for immediate "working" by the warplanes . . . . One of their cited leaders tells how it's done.

THOSE FIRST AMERICAN BOMBERS to attack Guadalcanal, when that famous island was still a Jap base, took off from an unfinished airfield, freshly carved from the green flanks of the jungle by sweating dungaree-clad sailors—the first of the Seabees.

The almost fabulous achievements of these veteran construction men, who donned Navy blues so that they could fight as well as build, already have become a legend of World War II.

Today, two years after their creation, the Naval Construction Battalions—to use the Seabees' official designation—are still looked upon by a large section of the public as being an adventurous cross between Robinson Crusoes and pirates. But military men recognize these battling builders as skilled technicians and ingenious improvisers as well as good fighting men—for it was these island-to-island trail-blazers who hewed out the advance bases which are now the jumping-off places for American ships and planes.

This morning's newspaper headlines of air and sea offensives often are directly traceable to yesterday's Seabee construction. The airfields of New Georgia, now an offensive spring-board for the Allies, were rushed to completion by the Navy's fighter-builders, who landed at Segi with bulldozers, power shovels, and trucks the day the invasion started. Nine days from the moment the first tree was uprooted, the first fighter plane made an emergency crash landing on the coral strip. Two days later, planes were taking off.

When Allied forces occupied the Russell Islands, Seabee bulldozers trundled ashore from some of the first invasion craft to pull against the beach. At now famous Henderson Field on Guadalcanal, a Seabee battalion worked through a rain of bombs to finish its job.

A few hours after first picture was taken, field looks like this. Broken fronds and coconuts litter ground.

First load of underwater coral arrives. Meanwhile, top layer of humus has been stripped from tract preparatory to laying coral.

After being pulverized, soft coral is spread over surface of air strip as top covering.

Field nears completion It is being graded and wetted down, both to prevent dust and to bind surface. The planes will quickly be "working" in and out of this field.

MILITARY

Even as Navy construction men complete one island airfield in the Pacific, other Seabees, 500 mi. nearer the setting sun, are surveying new landing strips—setting the stage for new offensives against the back-tracking Japs.

As each forward step against the Nippos is first mapped out, officers of the Navy's Civil Engineer Corps which, under Bureau of Yards and Docks supervision, directs the Seabees in the field, "sit in" with the Army and Navy tactical staffs. On their map, a red circle will go around the island selected as the next stepping stone to Tokyo. Along with other military installations, an airfield will be needed . . . and the job is assigned to one of the Navy's engineering officers.

His is no desk job. True, he may initially launch his work in an office, but he will usually wind up right on, or over, the island, studying his setting at first hand. His reconnaissance will be conducted long before the first Allied assault troops hit the beach. In civilian life, this Civil Engineer Corps officer may have built anything from a subway to a swank Fifth Avenue fashion center. However, the first part of his present assignment will be completed not from a metropolitan office but from a plane—which at any moment may have to run a gauntlet of Japanese bullets.

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From cockpits of slow-poking O-52's, student observers have unique opportunity to witness actual ground maneuvers and to practice knack of directing "friendly" artillery fire against concealed "enemy" positions.

MILITARY

BUILDING THE AAF
PART VII

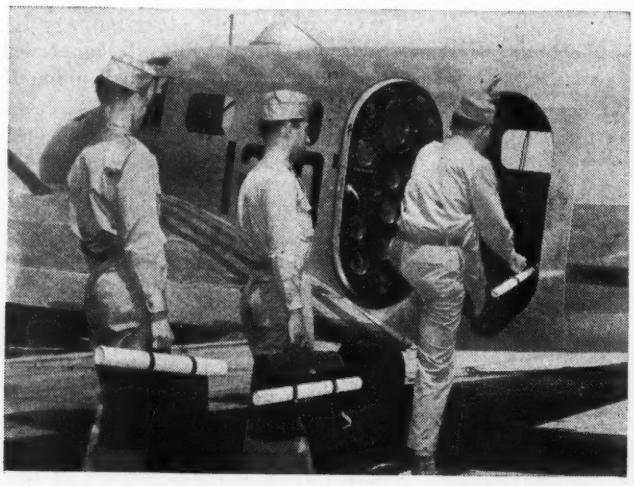
From Headwork to Helmsmanship

To route a target-bound bomber, avigator and observer must first be sure-fire on countless problems—of pilotage, radio, photography, camouflage, and communications. Described is the training which makes them trigger-quick on chart, phone, sextant, and shutter.

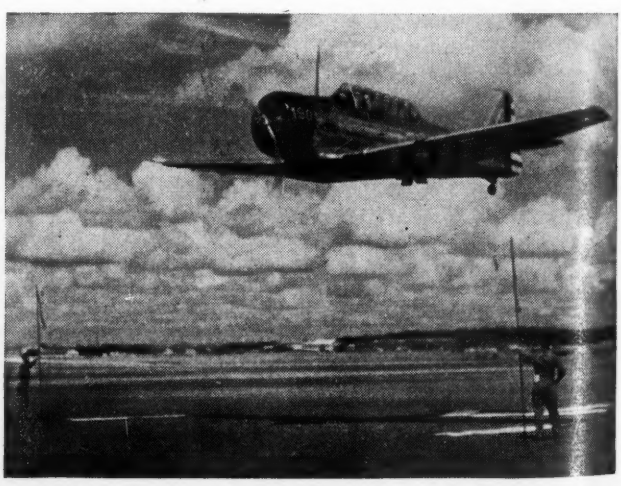
IT'S LIKE "OLD HOME WEEK" when graduates of the Army Air Forces Navigation School at Selman Field, La., take bombers over targets in Germany and Occupied France. They have already "covered" those routes long before in school. Their highly realistic pre-combat experience has made them extremely accurate in routing bombers to their targets, and their training "trips" have familiarized them with every hill, river, and town along the way.

Such trips are taken behind desks in the school's "Grope" department, center of the simulated mission training system. Prior to "going up," avigation cadets are assembled to hear a brief which is identical to that given before actual combat flights. Pertinent weather information is outled by an instructor, the objective is explained and described, and photographs of the real target and route are studied for landmarks. Further, maps are issued and plotted and times for takeoffs and landings are given. Then the cadet is ready to "leave."

Surrounded by all necessary avigational devices and equipped with various charts, the avigator seats himself behind his desk as the room is darkened. Aerial motion pictures of the ground are projected on a screen ahead



Ready for another examination, fledglings go aloft to apply many new principles learned in class room. This is first test mission. (Southeast AAF Training Center photo).



Besides learning art of high altitude communications work with "panel" code, well-rounded observer must become adept at hooking messages when radio goes dead. (USAAC photo.)

of him and the cadet proceeds to compute drift, speed, and other data necessary for charting the course. From figures taken by each cadet at intervals over the interphone system, the classroom "bombing planes" approach a tank factory in the heart of Naziland, drop their bombs, and make the return trip. Lights are then turned on to bring the cadet group back to earth again.

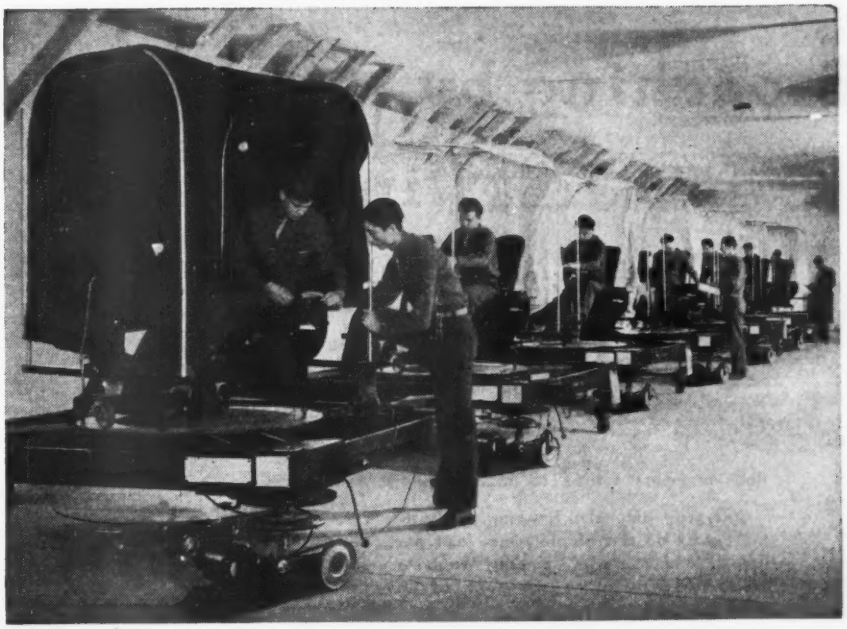
The "Grope" system is representative of the highly effective World War II instruction technique, which is being used at each of the avigation schools throughout the nation. Virtually every situation to be encountered by the avigator in combat is simulated in training—with the aid of sound effects and moving pictures. In addition, the cadet spends many hours in the air, plotting the course and directing the flight of planes in long training missions.

The wartime avigator holds undisputed claim to the title of "busiest man in the air." And for that reason no shortcuts are taken in his preparation for action. His schedule includes 9 weeks at Pre-Flight School, where he sharpens himself physically and mentally for the arduous 18 weeks advanced course which completes his training. In Pre-Flight, he prepares himself for a hard job that taxes muscles as well as mind, and he spends long hours in class, studying mathematics, physics, mission planning, aircraft and naval vessel identification, and a variety of other subjects. When he graduates to Advanced School, it is three more weeks before he gets into a Lockheed C-60 or an AT-7, twin-engine flying "classroom" for his first try at avigating in the air.

Let us run through a representative training mission which takes Selman Field's planes, cadets, and instructors from their home base on a dog-leg course to Clarksdale, Miss., and back—a round-trip of approximately 450 mi. Brief cases in hand, cadets are marched into a briefing room near the flight line prior to the start of their mission. As flight leader for the mission, Quentin R. Strong, a veteran instructor, briefs the trip while the cadets take notes, outlining the course and objective and method of avigation to be employed. Watches are synchronized and weather data is given by First Lt. Carl E. Helbock of Syracuse, N. Y., who is to pilot the flight leader's plane.

While the engines warm up, the cadets under Lt. Strong seat themselves at desks mounted in a row down the fuselage. Computers, maps, and charts are taken from brief cases, also instruments (a complete set of which sur-

(*Turn to page* 328)



In ground-bound "avitrainers" such as these, students get "feel" of plane while computing drift, airspeed, and other essential data.

Avigator's magic computer saves precious time in calculating speeds, heights, distances, and drift corrections. Here pathfinder plots course from initial bearing and directs pilot to target.

Actual practice in camera-shooting of "flats" and three-dimensional strips of terrain follows intensive instruction and thorough preliminary ground training. (USAAC photo.)

Cadet checks sextant after "shooting" sun. Plane is AT-7 trainer in which avigation missions are flown.

Broaching by *American*

PROVEN in war . . .

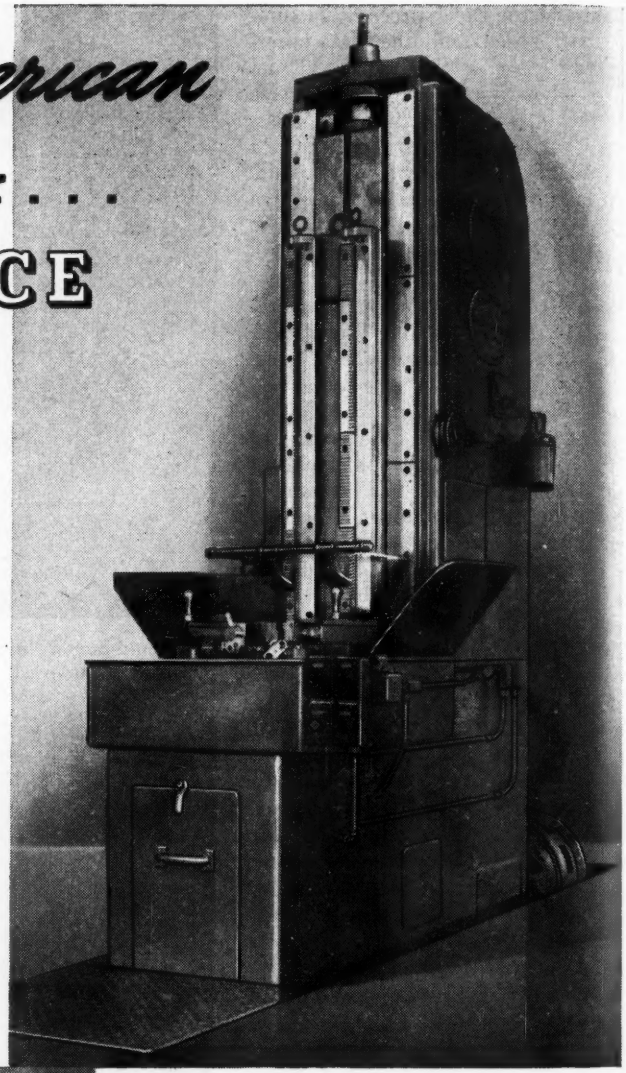
Ready for PEACE

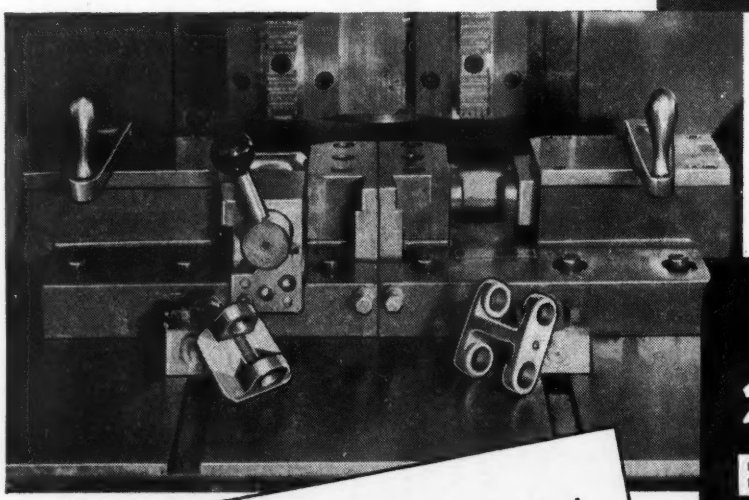
When war's demands made necessary precision production on a mass production basis, many leading production engineers turned to broaching—by *American*.

A typical example: finishing the surfaces between the bosses on aircraft universal joint parts. American Broach and Machine Company engineers—identified with broaching since the turn of the century—assumed responsibility for complete broaching equipment for this job. An *American* SB-54-10 single ram machine with receding work table was provided, equipped with a two station fixture designed to broach two end parts and one center part for a balanced production in each two machine cycles. (See illustration below.)

This is but one of the many war jobs where broaching by *American* is providing faster, more accurate and more economical production. When production planning is undertaken for peacetime products, *American's* complete service—machines, tools, and engineering—will be available.

Broaching is better the *American* way — proven in war, ready for peace!





(Above) *American* SB-54-10 Machine. Loading and unloading are synchronized with the machine cycle so that down time is zero . . . production high . . . finish excellent.

(Left) Parts broached in this operation are shown installed in the fixture, with two completed parts lying on the front of the table.

Use proper and sufficient lubrication when broaching. It is cheap life insurance for broaching tools.

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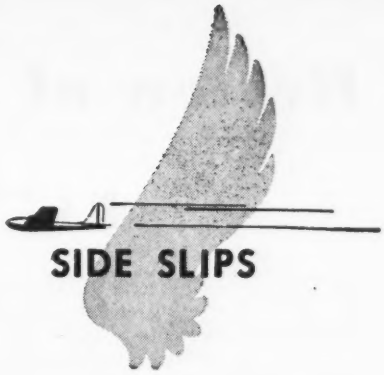


THE ARGUMENT on conventional vs. simplified airplane controls was getting good and technical. It was beginning to look like a long session when one of the group mentioned that most two-control planes seem, at take off, to have a moment of yaw. Whereupon the vice-president in charge of renegotiation and termination headed for the bar, saying: "Wish to goodness *I* could find somebody in a moment of yaw—the only answer I ever get is no!"

• "These four-engine bombers really give you room to stretch out and relax," thought the engine manufacturer's representative, who was getting full enjoyment out of the test flight. He didn't even think of the mountains 26,000 ft. below. But then the young pilot began to feather the props one by one—deciding on the spur of the moment that it would be interesting to find out what happens at that altitude when you feather all four at once. He glided through the frigid, eerie silence for what seemed like weeks, giving the service representative's imagination plenty of time to X-ray each freezing engine over and over. The service rep swears that even after the engines started again (without any trouble) the sweat still stayed frozen on his brow. In fact, he says, it didn't thaw out till after the third drink.

• Compiling a directory issue such as last month's entails headaches aplenty but it usually also brings forth a laugh or two. This year, though, a new note showed up, a note of pathos. In reply to our questionnaire one poor outfit could only say, "We do not feel it advisable to fill out the attached forms inasmuch as this company is being renegotiated out of business."

• Once more a great shipbuilder has shown aircrafters "how to produce." But once more, unfortunately, the "production" is in newspaper headlines only. Twenty months ago, it will be remembered, this g.s. announced he could build 5,000 Martin *Mars* flying boats a year, delivering the first in ten months, or in June 1943. The announcement produced reams of headlines and hosannas. But June 1943 came and went without a plane being delivered. In fact, not one had been produced outside the Martin plants, for the program had been quietly—very quietly—shelved for a new one, an $18,000,000 contract calling for three huge flying boats on which Howard Hughes' organization had long been at work. Under this contract, the first plane was to have been delivered in December 1943, the second this month, and the third next October. December has come and gone, but no delivery has been made. This month will come and go, but no delivery will be made. It would thus seem high time—particularly with Navy fighter planes still sorely needed—to modernize the proverb from "let the cobbler stick to his last" to "let the shipbuilder stick to his ways." And no pun is intended.

• The young man across the aisle had a very penetrating and durable voice. Even if the lounge car batteries had had power enough for light to permit reading, or the train hadn't spent an extra hour and fifty minutes quietly parked between stations, the young man would have prevented his neighbors from reading or sleeping, for he evidently liked to be sure everyone in the car realized the great importance of his job (which, as a matter of fact, anyone of average intelligence and energy could do). The third hour of the monologue was the most interesting, though. 'Twas then that he discussed personalities—by name—of big and little shots throughout his company. From that he went to production schedules, not only of the company's current plane, but on a new model just being readied. He even gave the approximate date set for the test flight of a new supposedly super-secret craft. *Maybe* enemy agents weren't listening to the young man, and *maybe* no American soldiers will be needlessly killed because of him—but we'd hate like hell to count on it.

"'Sorta took the play away from Mr. Maguire when Oscar Octopus began demonstrating what *really* happened in that dogfight."

Review of Patents

By A. HARRY CROWELL

Registered Patent Lawyer

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any of patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

Joint for Aircraft Structures. This patent is for a connection for thin walls or shells of hollow aircraft bodies. It aims to provide relatively great structural strength and rigidity with least weight and minimum projection beyond the plane of the shell or skin surface. Further, like sections of this same skin material can be joined. Flange elements fastened to skin elements abut each other in a transverse plane normal to the skin elements, with diagonally extending attachment means connecting each pair of diagonally opposite flange elements.—2,334,844, filed Oct. 18, 1941, patented Nov. 23, 1943, T. B. Salter, assignor to Cessna Aircraft Co.

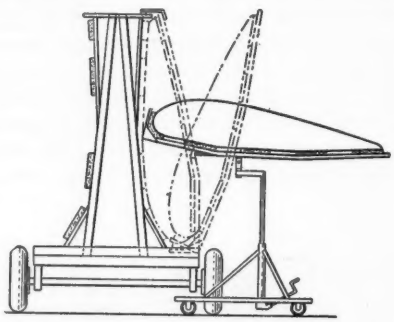
Control-Surface Mounting. Balance, both static and dynamic, of control surfaces of high speed aircraft in order to eliminate flutter are stated to be obtained in this mounting by provision of a bifurcated-form hinge bracket having a central opening within which surface spar is free to be moved.—2,334,848, filed May 20, 1941, patented Nov. 23, 1943, A. J. Thiebolt, assignor to Fairchild Engine & Airplane Corp.

Variable Pitch Airscrew of constant-speed type is subject matter of patent calling for electrically operated propeller with means for increasing pitch-change when difference of speed from required value exceeds a predetermined amount. Increased rate of pitch-change is effected by increasing voltage supply to motor, causing it to run at a higher speed so desired correction of speed is more rapidly effected.—2,334,967, filed Mar. 19, 1942, patented Nov. 23, 1943, F. M. Thomas, D. J. Kenney, and P. R. Price, assignors to The Bristol Aeroplane Co., Ltd.

Pick-Up System Device. This is shock absorbing means for airplane pick-up and delivery operations. Provided is method and apparatus for simultaneously picking up and discharging articles from an aircraft while in flight, with specific means for eliminating shock both to the apparatus used on ground and to the aircraft. A springing, pivoted arm applies a "yieldable" force to load coming from ground in the direction in which load is to be moved. Load is first held by weight in equilibrium against yieldable force, then a limited pull is applied to load by line from aircraft and initial force is augmented by the swing of the springing arm giving first impetus to load.—2,334,979, filed Oct. 24, 1940, patented Nov. 23, 1943, L. S. Adams, assignor to All American Aviation, Inc.

Adjustable Wing-Gun Mount is for purpose of decreasing weight of weapon's installation by making adapter a cantilever supported wholly by one of wing spars. Means is provided for adjusting elevation and traverse of fixed guns in aircraft, also means by which aircraft crew may change gun elevation with respect to flight axis of airplane. In one form of invention, whole gun assembly is carried as a cantilever rearward of rear wing beam, and access for replacing ammunition containers and for laying gun is provided through appropriate openings in wing skin.—2,334,984, filed Mar. 8, 1940, patented Nov. 23, 1943, D. A. Berlin and C. G. Trimbach, assignors to Curtiss-Wright Corp.

Propeller De-Icer. This invention particularly concerns prevention of formation of ice on blades of adjustable-pitch propellers. Provided is a conduit construction for hollow airscrew blades to bring de-icing fluid to leading edges of blades. Fluid is also fed to leading edge of a cuff or fairing embracing root portions of a propeller blade.—2,335,018, filed Dec. 9, 1939, patented Nov. 23, 1943, E. W. Morris and J. H. Sheets, assignors to Curtiss-Wright Corp.



Big parts handler, recently patented, device for expeditious handling of bulky plane parts, such as wings, stabilizers, etc. Sketch shows it in phases of loading wing section on specially fitted trailer truck. Essentially, apparatus comprises vertically adjustable column, an elongated table pivotally supported on upper end of column, collapsible legs connected with column, and adjustable braces interconnecting column and legs. It is adaptable for dismantling and assembling operations in factories, hangars, or repair shops, as well as on irregular terrain.—2,335,692, filed Jan. 30, 1943, patented Nov. 30, 1943, T. W. Murray.

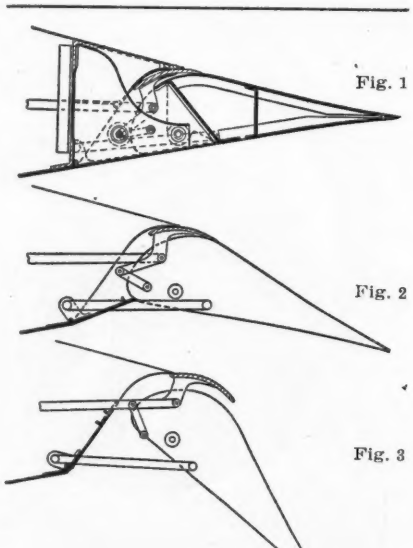


Fig. 1

Fig. 2

Fig. 3

This slotted-flap mechanism is designed for improved wing-lift control in high speed airplanes, especially those military craft where, at positions of partial flap deflection, it is of utmost importance to avoid roughness in the airfoil surfaces. As shown in drawings, device achieves closed-slot effect. Fig. 1 depicts flap in closed position; Fig. 2, partially deflected for maneuvering, climbing, or takeoff; and Fig. 3 in fully deflected high-lift, high-drag landing position.—2,334,975, filed Nov. 13, 1941, patented Nov. 23, 1943, W. W. Williams, assignor to Bell Aircraft Corp.

New Valve Device is adapted to close on, or open away from, a seating set obliquely across conduit. And it is formed with (or carries a skirt provided with) a passage of cross sectional diameter substantially equal to that of conduit. Through this arrangement, when valve is in fully open position, passage forms a continuation of conduit, thereby insuring an even flow. Spring means may be used to operate valve in one direction; hydraulic means for operating it in other.—2,335,067, filed June 17, 1942, patented Nov. 23, 1943, M. Langley, assignor to Flight Refueling, Ltd.

Parachute Jumper's Hatch. This special chutists' exit is applicable either to civil or military craft. Incorporated in tail end of plane, it may be opened from interior to form platform and a hatch through which jumper may safely bail out aft of plane. A sliding door arrangement is provided.—2,335,090, filed Aug. 27, 1941, patented Nov. 23, 1943, T. W. Swiech.

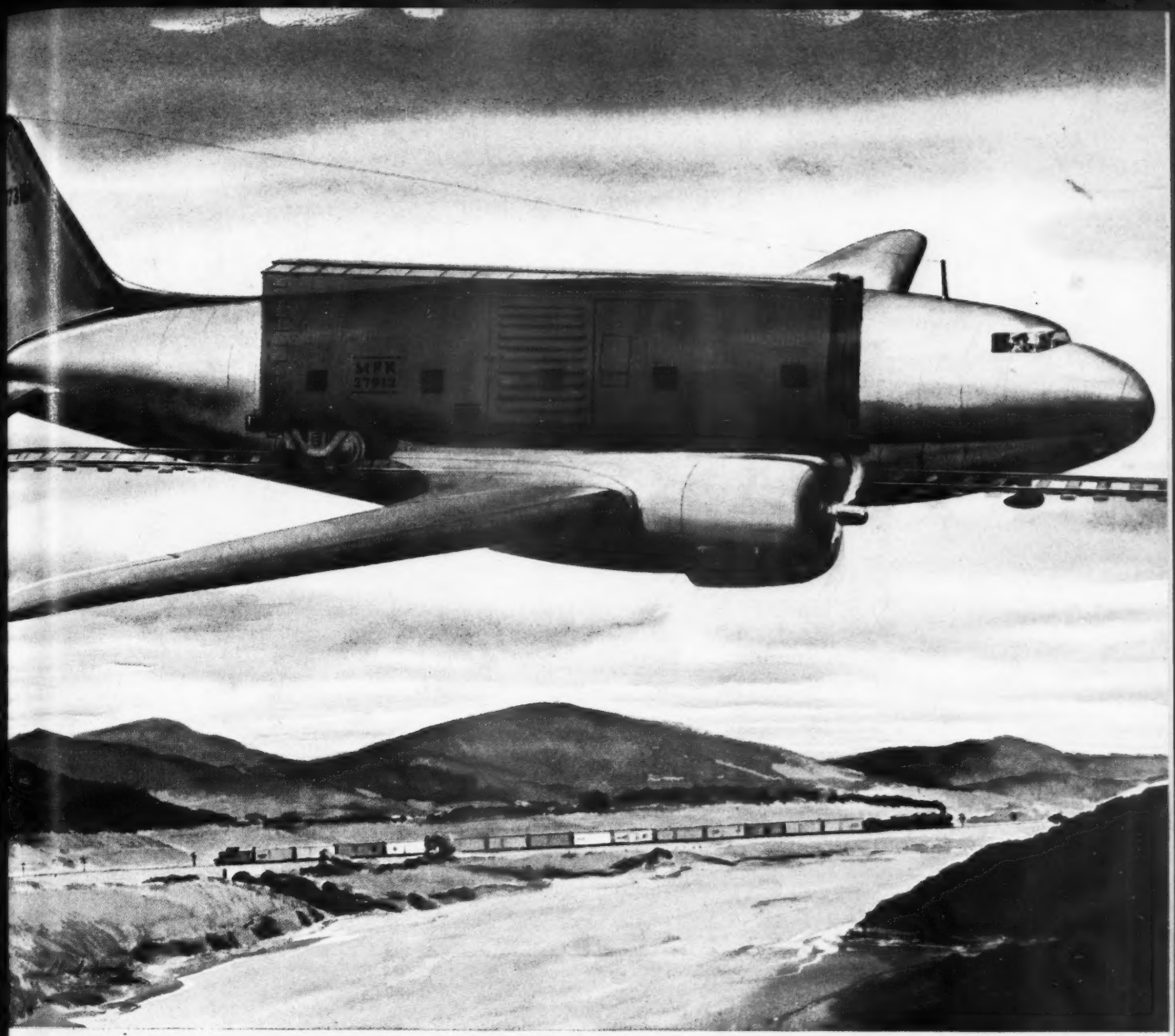
Aircraft Gunnery Device. Invention here is weapon arrangement with improved sighting means. Especially designed for use on high-speed aircraft where ascent is on streamlining, device allows mounting of gun in a turret of minimum size and with minimum projection of weapon from body of aircraft. Included is articulated gun sight having a view piece or objective moving in fixed relation to it and having an eye piece supported so as to have movement different from that of view piece, means being provided for holding eye piece (and hence gunner's line of vision along weapon) substantially parallel to view piece. There is also a lens and reflector system which will keep field of gun sight from rotating, the pertinent parts being arranged for angular movement.—2,335,286, filed July 17, 1939, patented Nov. 30, 1943, W. B. Klemperer and A. Corte, assignors to Douglas Aircraft Co., Inc.

Heavy Caliber Gun Mounting incorporates design for improved ammunition magazine and feeding mechanisms in conjunction with a plurality of mounted weapons. Magazine comprises a shell or cartridge trackway of substantially semi-cylindrical form which is adapted to nest against, and closely conform to, adjacent wall portion of fuselage in region above gun casing. Trackway may be conveniently dimensioned and proportioned to carry a substantial supply of side-by-side aligned shells.—3,335,449, filed July 9, 1941, patented Nov. 30, 1943, F. M. Salisbury, assignor to Bell Aircraft Corp.

Gravity-Plane Locator is apparatus for quickly and accurately determining longitudinal position of plane of gravity of a loaded aircraft, or other vehicles or objects. Device includes platform upon which plane is rolled, a plurality of lever systems of unequal ratio by which ends of platform are supported, change levers of variable fulcra connected to the systems, a weight indicating mechanism, and additional adjustable poises connected with change levers for determining locus on platform of plane of gravity of aircraft.—2,336,142, filed Jan. 30, 1941, patented Dec. 7, 1943, O. H. Watson.

Airport Gasoline Dispensing System covered by this patent provides an apparatus disposed entirely under ground or water in order not to interfere with movement of aircraft when not in use. There is provided a gasoline storage tank and above it a pit, comprising a metal watertight container, to house dispensing mechanism. Pump is of impeller type with provision for separating water from gasoline being carried by discharge conduits.—2,336,150, filed June 24, 1940, patented Dec. 7, 1943, A. G. Horvath, assignor to Dayton Pump & Mfg. Co.

Tachometer. This instrument, designed for both efficiency and low price, is of well known rotatable permanent magnet type, with fixed field cup and a rotatable speed cup.—2,336,172, filed Oct. 20, 1941, patented Dec. 7, 1943, R. O. Helgeby, assignor to General Motors Corp.



Today's military flying freight car available for tomorrow's air commerce

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2,000,000—All-Americans

Today, not eleven men but more than two million make up the greatest All-American team in history. They are the flyers and ground crews of the U. S. Army Air Forces—and instead of a gold football on their watch chains, they wear the Army Air Forces' winged insignia.

On every play to date, these boys have strafed gaping holes in the enemy lines allowing our ground forces to get through for immeasurable gains. Their passes over the Reichland are causing panic. The only "spinner" they think of is a Zero crashing in flames.

Bell Aircraft is proud of its three-way role in helping to equip this greatest of All-American teams. Our Niagara Frontier Division has produced thousands of Bell Airacobras that have wrought havoc with the enemy on many fronts. Today, this division is also building a new type of fighter plane with even greater performance and before long, it *too* will be in the scrimmage.

Our Ordnance Division in Burlington, Vt., is working night and day building the flexible gun mounts which give the boys in the turrets the accuracy of firepower that is knocking the enemy out of the skies at a terrific rate.

And soon, from the new Bell Bomber Plant in Georgia, will come more planes to help speed the day of victory.

Some day, soon we hope, this team will be returning to its home grounds. And when it does, it will find Bell Aircraft pioneering in building equipment for a peacetime nation on wings. © Bell Aircraft Corporation.

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL—EAST COAST, INC.

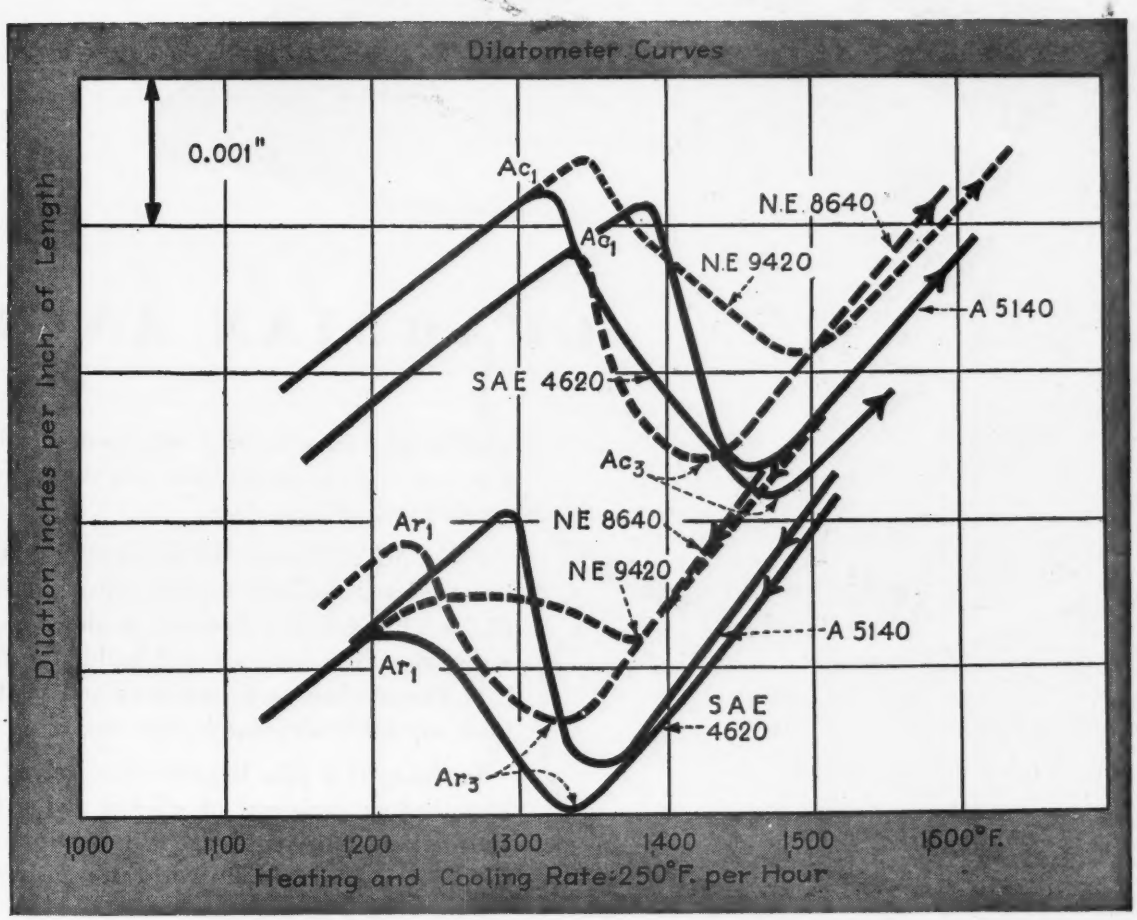
BELL *AIRCRAFT*

Niagara Frontier Division, Buffalo and Niagara Falls, N. Y.
Ordnance Division, Burlington, Vt.
Georgia Division, Marietta, Ga.

PACEMAKER OF AVIATION PROGRESS

BUY WAR BONDS AND SPEED VICTORY

Heat Distortion Of NE Steels



ALL NE STEELS are fine-grain alloys produced by the best practice known to the industry with a hardenability equal to the grades they are used to replace. Selection of an NE steel of higher carbon content often results in much unnecessary trouble in processing, due to excessive hardenability. NE chromium-nickel-molybdenum steels are well adapted to the utilization and recovery of alloys from scrap and thereby aid in meeting mill production schedules, a matter of prime importance.

When NE chromium-nickel-molybdenum oil-hardening steels first were produced a decrease was noticed in heat-treat distortion as compared to SAE steels. This permitted quenching at higher temperatures than those formerly considered normal. This higher quench is not objectionable because distortion will still be the same or less than in former grades, with equal hardness. A comparison of dilatometer curves is given above.

GUARDIAN ANGEL

They're on their way, deep into enemy territory—a fleet of Forts at 30,000 feet, with their guardian angels perched high above.

FW's? ME's? Zero's? Any Axis fighter that pokes its nose up at the bombers is a "sitting duck" for diving Thunderbolts. Because, at the Army's request, Republic designed and builds the famous P-47 Thunderbolt to fight higher and hit harder than any other airplane in the world.

In doing this job, Republic has solved many longstanding problems of efficient flying in the stratosphere. This knowledge will contribute much to America's leadership in world air transport after the war—when giant airliners will travel faster and more economically—because they'll fly high where the flying is best. Republic Aviation Corporation, Farmingdale, L. I., New York, and Evansville, Ind.

FARMINGDALE DIVISION

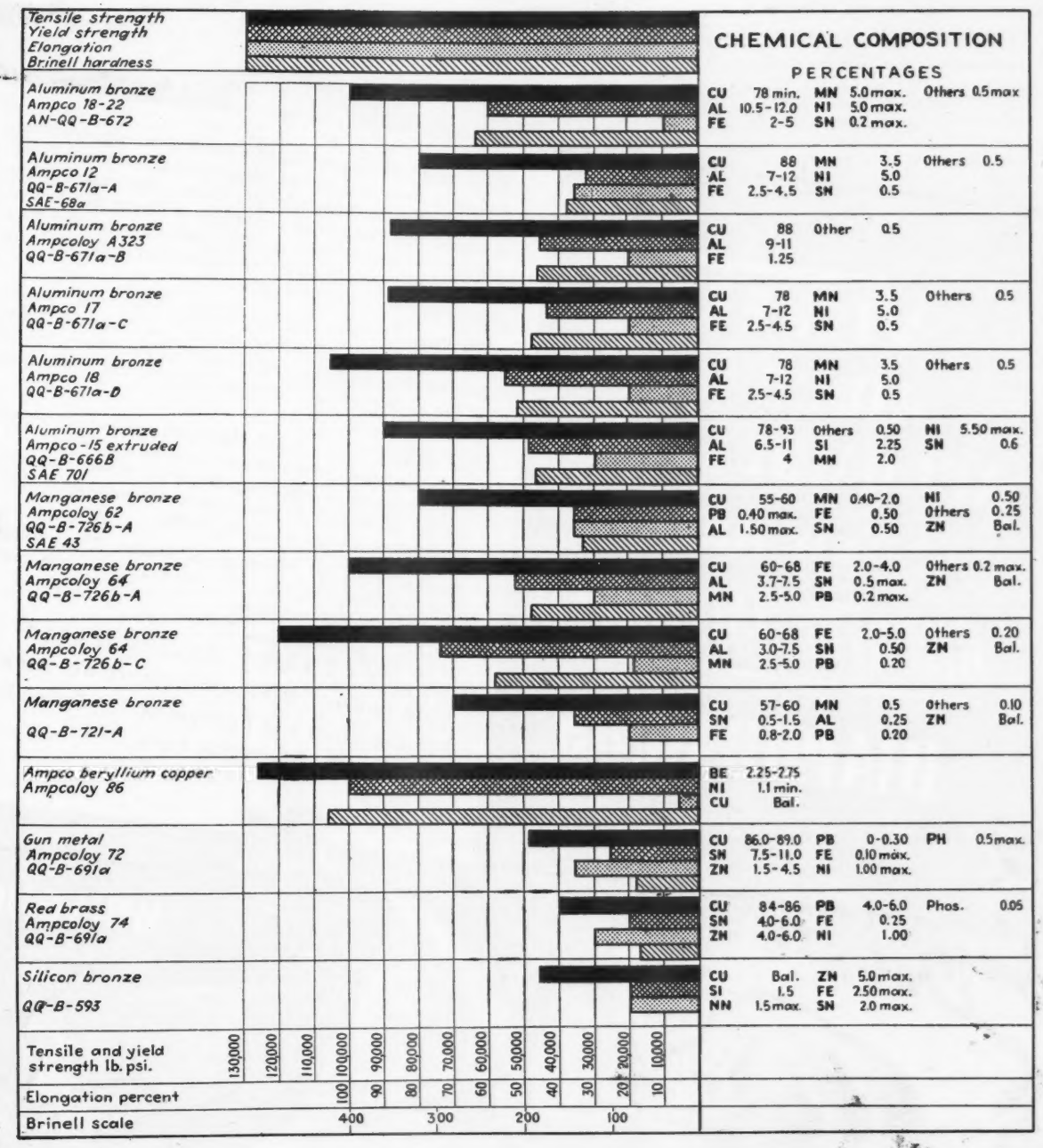
REPUBLIC AVIATION CORPORATION

SPECIALISTS IN HIGH-SPEED AIRCRAFT

MAKERS OF THE

Thunderbolt

Ampco Copper-Base Alloys



THE LIST above tabulates Ampco copper-base alloys and gives physical and chemical properties of those products specified for Government work. It is to be noted that beryllium-copper has characteristics very different from the copper base.

Vickers Accumulator with Polar Diaphragm is recommended for military aircraft. It meets requirements under Winterization Test and has Yellow Dot.

VICKERS AIRCRAFT ACCUMULATORS Now Have *GREATLY IMPROVED* DIAPHRAGMS

Much longer diaphragm life is the result of the improvements that have been made in the diaphragms of Vickers Aircraft Type Hydraulic Accumulators. These diaphragms were achieved from exhaustive research in synthetic materials in cooperation with leading synthetic manufacturers and have been proved by our accelerated laboratory tests; they are now used on all our production.

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The Vickers "Rhino-Hide" Diaphragm is used for average flying conditions where temperatures are not below —25° F. This diaphragm is extremely tough: on breakdown tests a number of them have been cycled the equivalent of 5000 flight hours and are still going strong.

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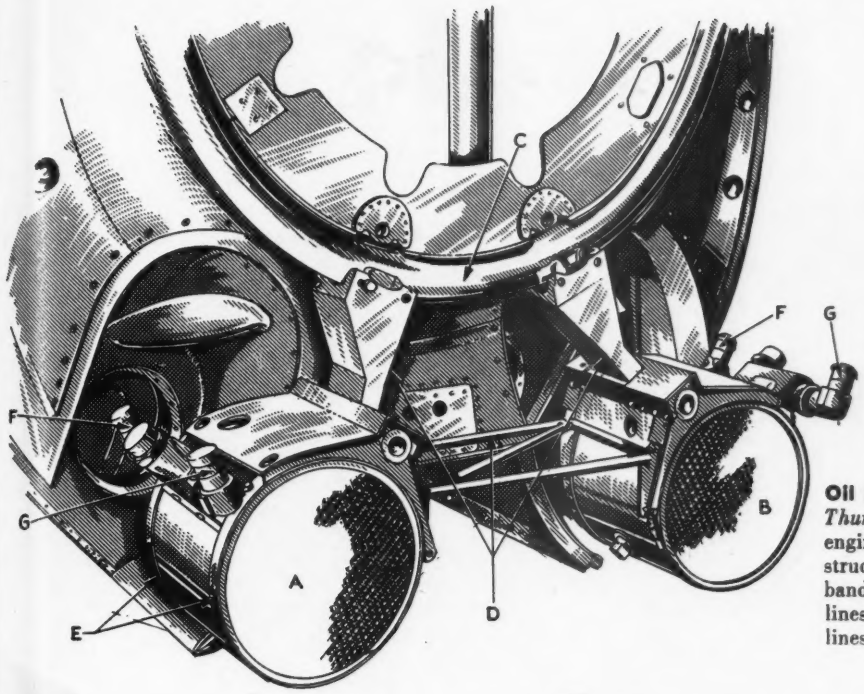
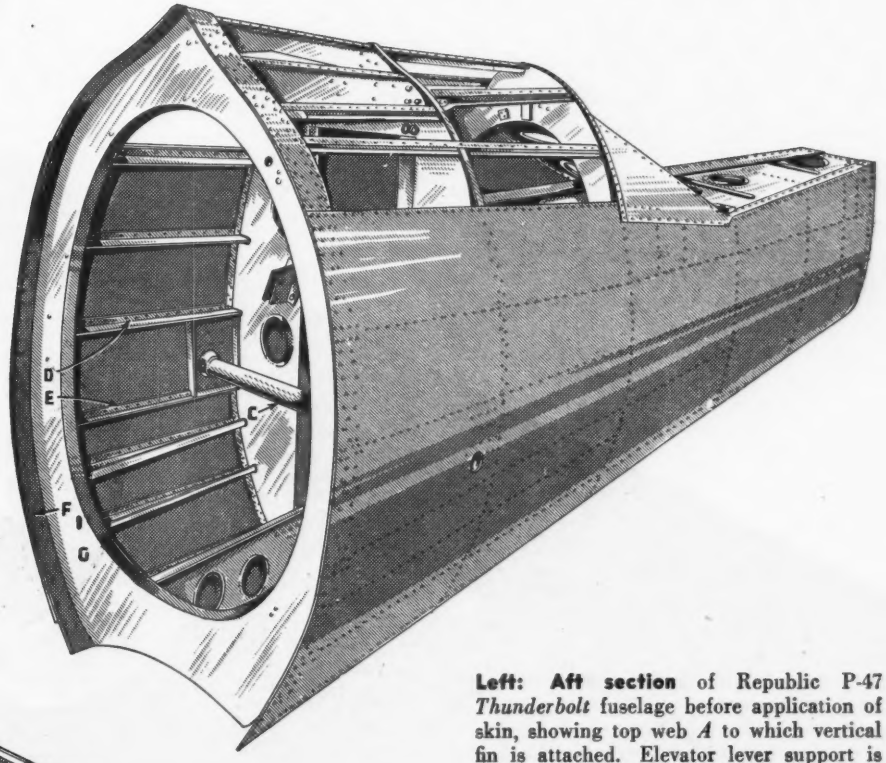
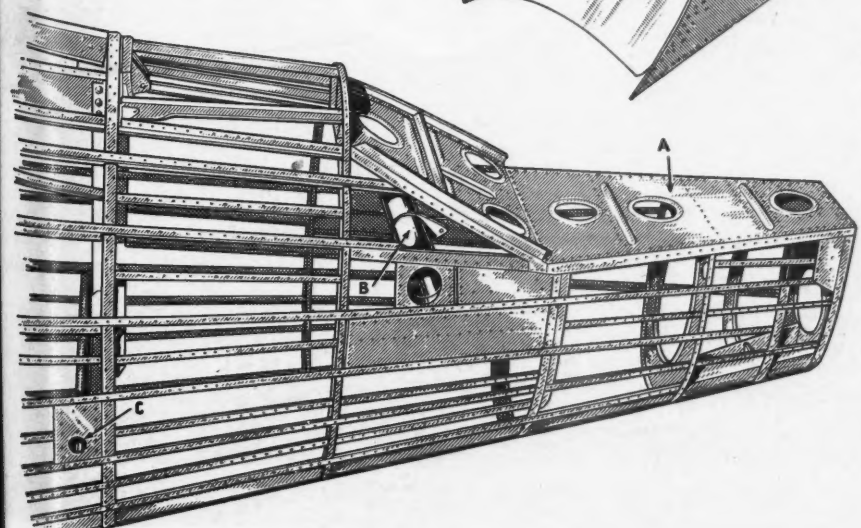
Vickers Accumulator with Rhino-Hide Diaphragm is recommended for normal service conditions.



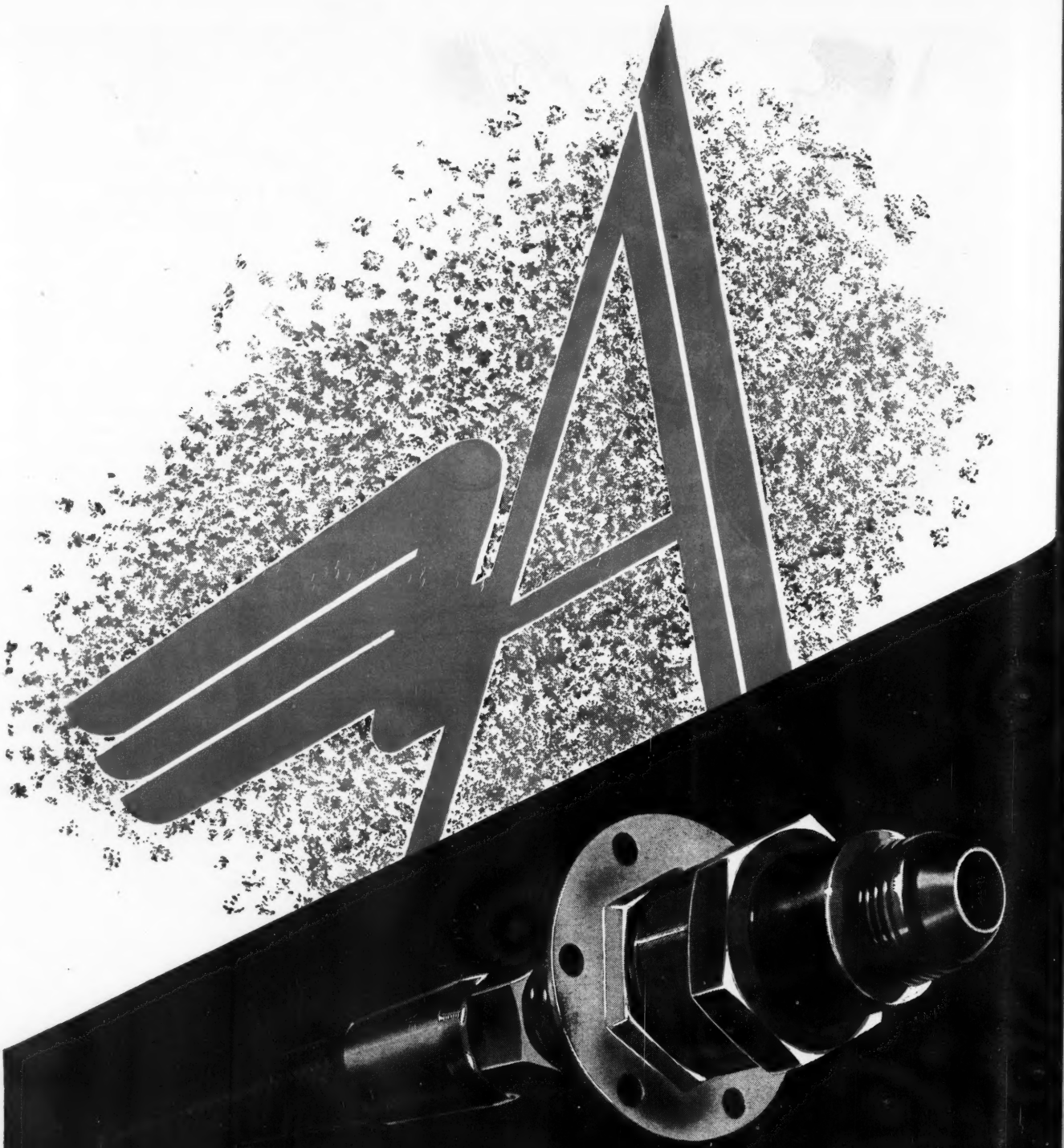
SKETCH BOOK OF DESIGN DETAIL

Oil radiators *A* and *B* on Republic P-47 *Thunderbolt* are attached to lower part of engine mount ring *C* by support bracket structure *D*, being held in place by flexible bands *E*. Oil enters radiators through rear lines *F* and is returned through forward lines *G*.





Left: Aft section of Republic P-47 *Thunderbolt* fuselage before application of skin, showing top web *A* to which vertical fin is attached. Elevator lever support is at *B* and tube for lift bar is at *C*. Sketch above shows different view of same section with most of flush-riveted skin in place. Note method of attaching lift tube *C* to fuselage skin via web plate attached between stringers *D* and *E*. This section of fuselage is attached to fore part of fuselage by rivets around skin at *F* just ahead of frame *G*.



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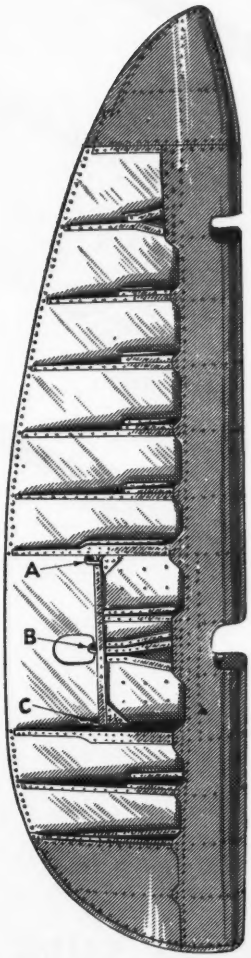
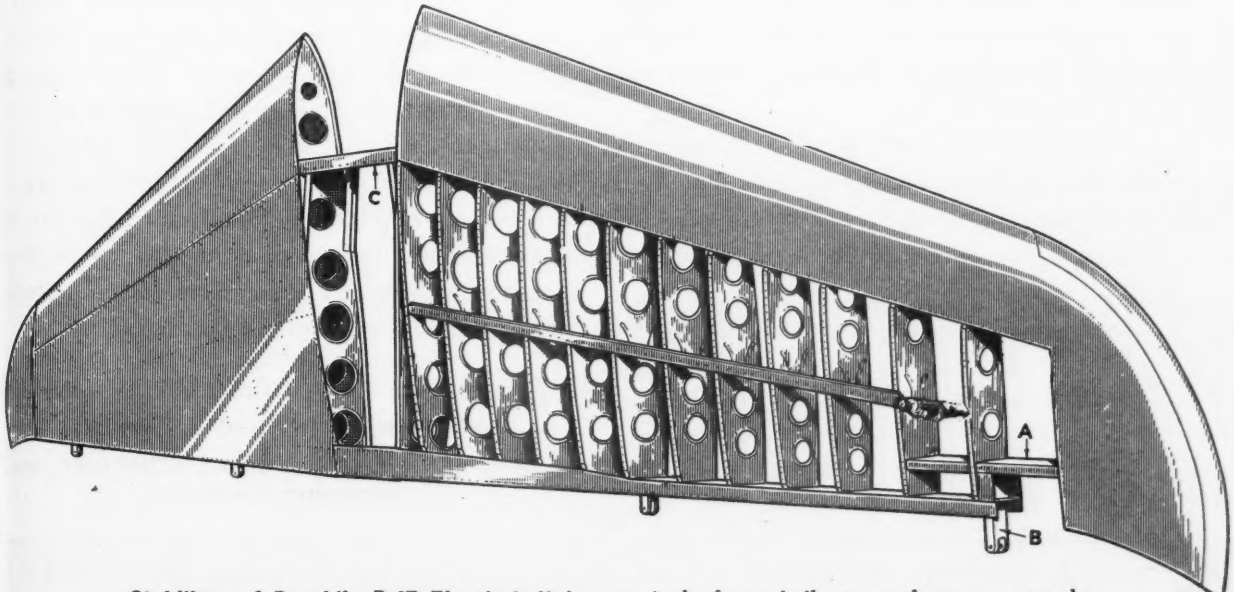
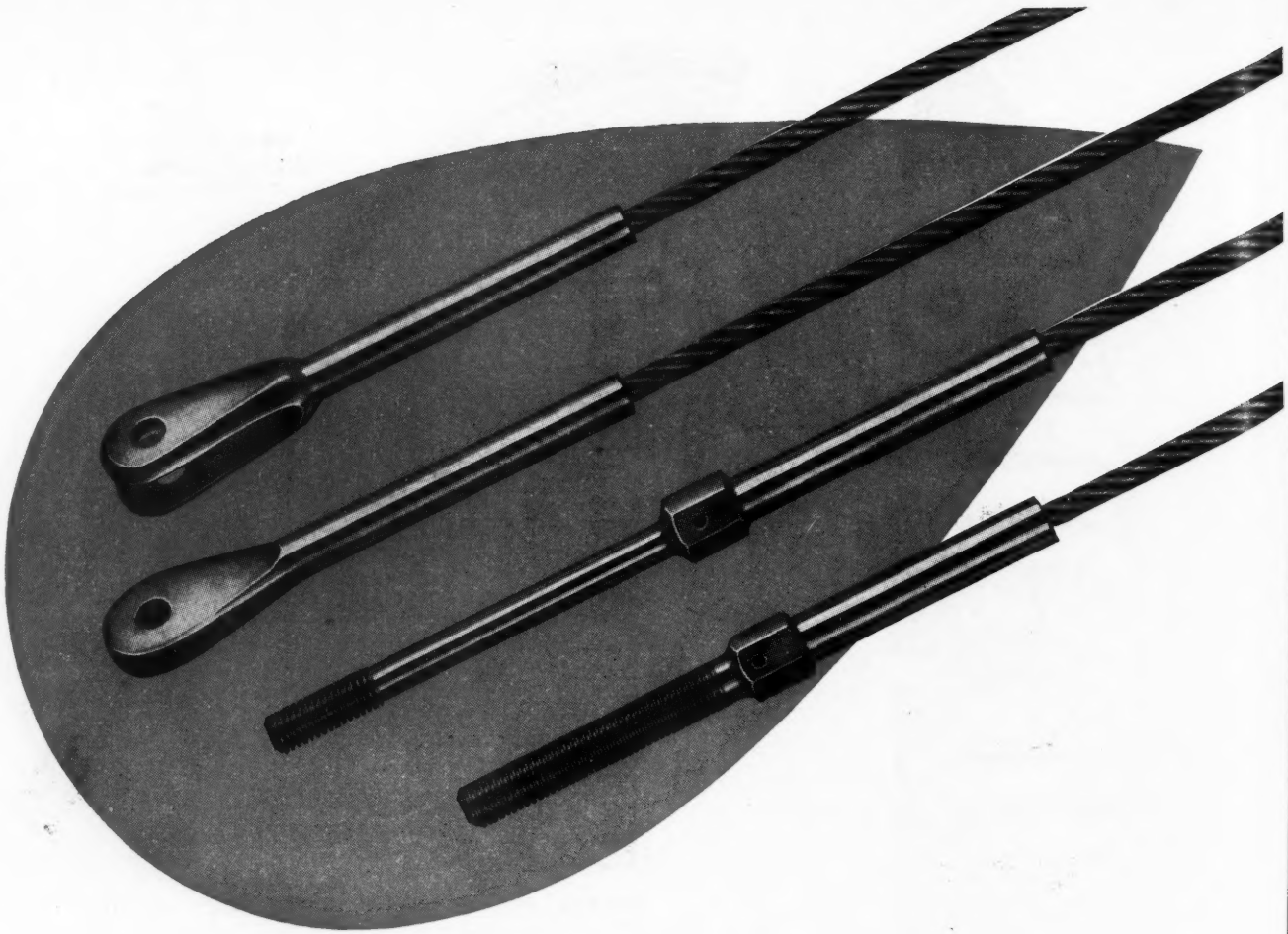


Monospar rudder of Republic P-47 *Thunderbolt* follows conventional design practice, with metal spar, stamped metal ribs and flush-riveted metal covering. Trim tab hinge points are at *A*, *B* and *C*, with portion of skin shown in place during construction to be cut away to form half of trim tab itself.

Republic P-47 *Thunderbolt* vertical fin utilizes two built-up metal spars, metal ribs, and flush-riveted metal covering. Stamped ribs with lightening holes are attached to front spar through angle brackets as shown at *A*, *B*, *C* and *D*.



Stabilizer of Republic P-47 *Thunderbolt* is comprised of two built-up metal spars, stamped metal ribs, and flush-riveted metal covering. Note false spar *A* extending beyond elevator hinge point *B* at end of rear spar. Attachment to fuselage is by bolts along spars at *C* and *D*.



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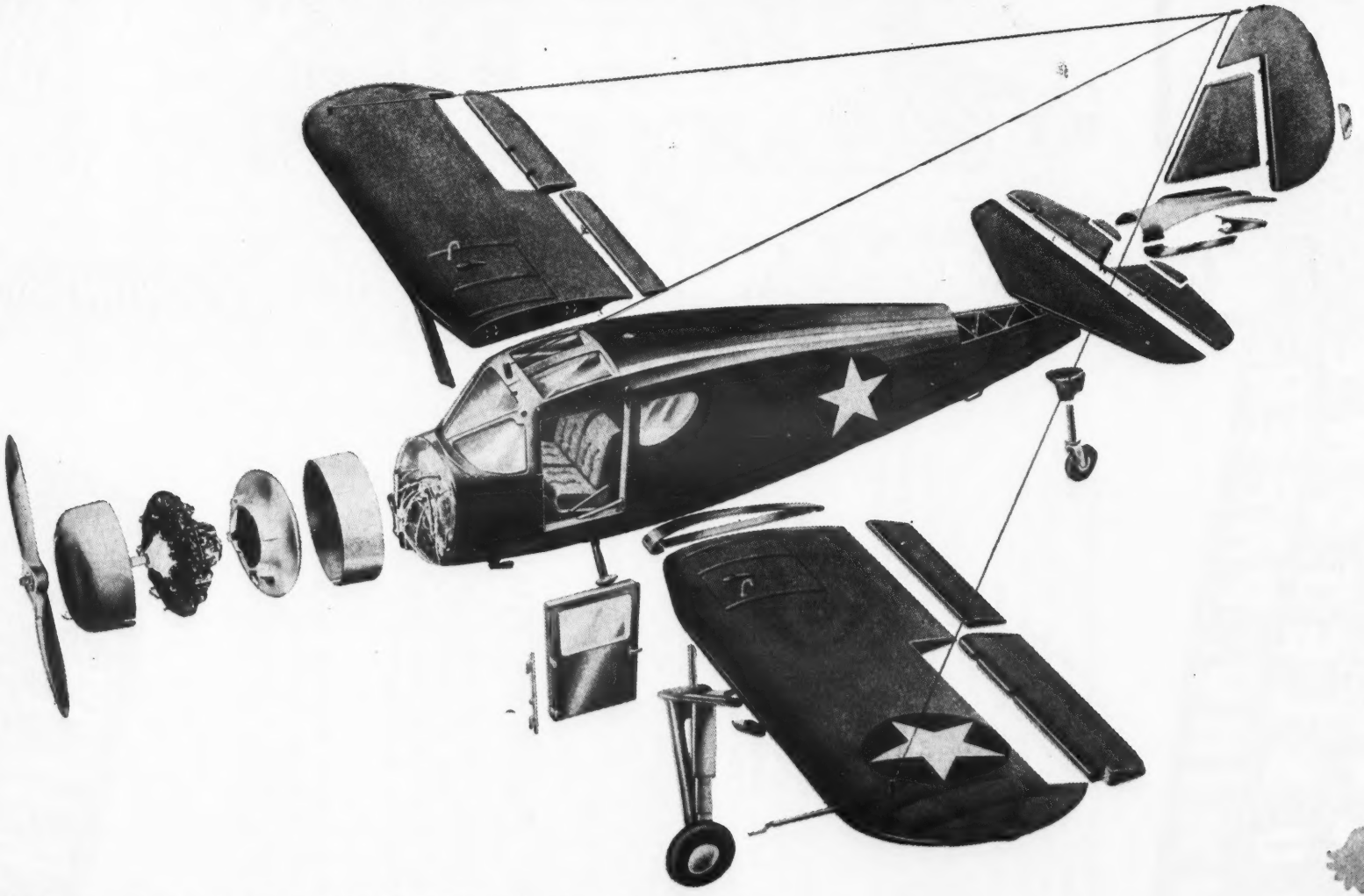

Exploded view showing major components of Fairchild UC-61A *Forwarder*, developed from well known F-24, used by Army Air Forces as personnel and light cargo carrier. Fuselage is of welded steel tubing, fabric covered, while wings are two-spar wood construction, also fabric covered. Ailerons, elevators and rudder are fabric covered metal; fin and stabilizer are of spruce frames, plywood covered. Equipment includes electric starter, two-way radio, full night flying equipment, and two 30-gal. fuel tanks.

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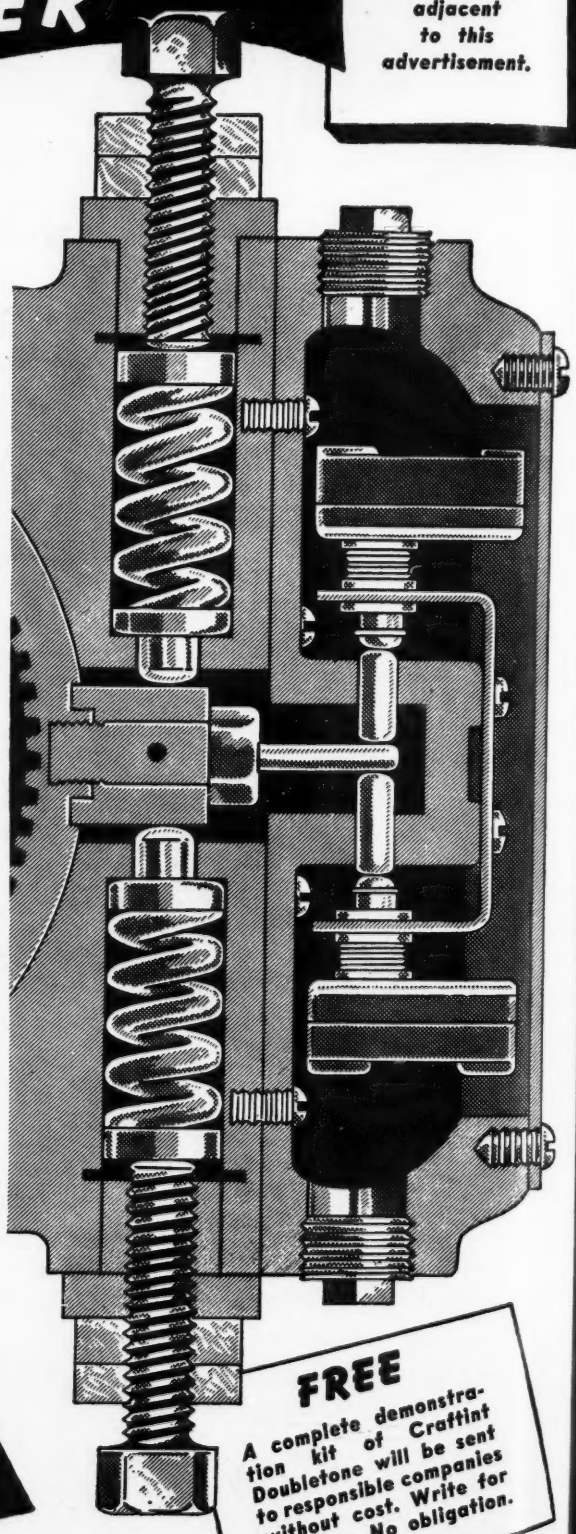

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Information supplied by an Industrial Publication

There are two operational factors that have more to do with the life and efficiency of reamers than may be generally known. One is the matter of feeds and speeds; the other, the condition of the hole.

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The amount of stock left in the hole has considerable effect on reamer life. If there is insufficient stock, the reamer will tend to bind instead of cutting. This is also true with bell mouthed holes, caused by faulty drilling, or drilling without a guide bushing.

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ENGINEERING DATA

Lubricant Chart 1

Wall chart on lubrication requirements of hydraulic systems, spindles, air compressors, reduction gears, high temperature oils, general plant lubrication, and electric motors has been prepared by E. F. Houghton & Co., Philadelphia. It also contains list of company's products designed to meet needs of this equipment.

Magazine Index 2

Parks Air College, East St. Louis, Ill., is compiling monthly index of aviation magazine articles which will be sent to those requesting it on official letterheads. Year-end cumulative edition has also been prepared.

Technical Book Catalog.....3

Technical books issued by Chemical Publishing Co., Brooklyn, N. Y., are listed with brief descriptions and tables of contents in new catalog. Subjects covered include physics, chemistry, mathematics, aviation, metals, and dictionaries.

Pyrometer Manual 4

Engineering information on selection and installation of thermocouples, protection wells, lead wire, well assemblies, and calibration data and tables is given in *Pyrometer Accessory Manual* released by The Bristol Co., Waterbury, Conn. Also mentioned are molten metal thermocouples, radiation and surface contact couples, and special fittings and adopters.

Forging Facts.....5

Steel Improvements & Forge Co., Cleveland, offers booklet, *The Improvement of Metals by Forging,* compiling technical information on types of forgings, forging design principles and processes, and metallurgy of forging. One section is devoted to specifications and properties of common steels, and text is interspersed with charts, photos, and drawings.

Standards List 6

Standards for safety and war production requirements are among more than 600 specifications in new list prepared by American Standards Assn., New York City. Sixty-four standards have been revised or approved since last list was issued a year ago. Material specifications, test methods, dimensions, and definitions of technical terms are among topics covered.

PRODUCTION

Spot Welders 7

Features, construction, and operation of several types of spot welders are set forth in information sheets prepared by Dyer Welder & Engineering Co., Kansas City. Specification tables cover such components as throat depths, electrode and horn diameters, and maximum pounds pressure.

Torch Brazing 8

Diagrams and text in broadside from Handy & Harman, New York City, on low temperature brazing with its silver alloys consider fit of joint, cleaning, fluxing, assembling, heating, applying alloy, and flux removal.

Anti Zinc-Corrosion 9

For increasing rust-resistance of zinc-coated steel parts and retarding white zinc corrosion, United Chromium, New York City, is marketing Anozine, salts which are dissolved into dipping solution. Process is described in illustrated folder.

Fasteners 10

Suggestions from Fastening Headquarters, large-format booklet, shows details and uses of varied types of fastening devices manufactured by Shakeproof, Inc., Chicago.

Low Temperature Welding.....11

Eutectic low temperature welding process, developed by Eutectic Welding Alloys Co., New York City, is fully described in booklet illustrating various materials and situations in which it is applicable.

Thread Grinding 12

Thread Grinding Simplified, bulletin issued by Dumore Co., Racine, Wis., has drawings and charts of helix angles for Acme and U. S. Standard screw threads, plus photos and brief instructions to show workers how to mount and use company's thread grinding equipment.

Rivet Sorting Service.....13

Manufacturers may send floor sweepings, following which sorted rivets obtained from them are returned. Service is described in leaflet distributed by Rivomatic Aircraft Rivet Sorting Service, Titusville, N. J.

Induction Heat Treatment.....14

Tocco process of high frequency induction heat hardening of low carbon steels is analyzed in booklet printed by Ohio Crankshaft Co., Cleveland. Photos, tables, and curves supplement text prepared by firm's research and development engineer, Dr. H. B. Osborn, Jr.

Flux Recommendations 15

Chart, available from Krembs & Co., Chicago, lists common metals and alloys and recommends proper flux to be used in welding, brazing, or silver soldering ferrous and nonferrous metals.

Parts Finishing 16

Engis Equipment Co., Chicago, illustrates in broadside kinds of engine and instrument parts to which its Hyprez finish can be applied. Specified for articles requiring frictionless movement, finish can be applied by company to articles already prepared by machining, grinding, honing, or lapping, or company will supply parts ready-finished.

Parts Packaging 17

Military specifications for wrapping parts, types of Cellophane applicable, types of wrappers, and methods of packaging are summarized on chart prepared by Cellophane Technical Section, E. I. duPont de Nemours & Co., located at Wilmington, Del.

Filtering Medium 18

In 67-page booklet, Moraine Products Div., General Motors Corp., Dayton, Ohio, shows applications and gives engineering information on Porex, new powder metallurgy medium, in filtration, separation, diffusion, and flow control applicable in many industries.

MACHINERY & ACCESSORIES

Carbide Tools 19

Carbide Fabricators Co., Royal Oak, Mich., publishes catalog of cemented carbide tipped tools—including those for turning, reaming, end milling, core drilling, and centering—along with specifications and general engineering data on machine work.

Turret Punch 20

Mechanical and design features of turret punch press for short run piercing operations are pointed out in Bulletin No. 92 of Wiedemann Machine Co., Philadelphia.

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Grinding Fixture 21

Grinding wheel attachment for holding drills at proper sharpening angle is illustrated in broadside prepared by E. Z. Manufacturing Co., Burbank, Calif. Company also lists specifis steps in restoring points of drills of several sizes.

Industrial Tools 22

Complete line of industrial tools manufactured by DoAll Service Co., Des Plaines, Ill., is shown in Catalog 102 which announces firm's entry into field of powder metallurgy. Among items described are contour and high speed sawing and filing machines, cutting and coolant oils, surface grinding machines, gage blocks and laboratory inspection sets, and variable speed regulators.

Band Filer 23

Operation and features of band filer in DoAll line are pictured in folder of its manufacturer, Continental Machines, Minneapolis.

Hydraulic Presses 24

A. B. Farquhar Co., York, Pa., is circulating bulletin with pictures and specifications of wide line of its hydraulic presses. Shown, too, are installations of various models.

Metallizing Apparatus 25

Catalog 42B, Metallizing Engineering Co., Long Island City, N. Y., gives details of firm's equipment for metallizing surfaces. Included are metallizing guns, wires, and surface preparing tools.

Bearing Servicing 26

Service Procedure for Ball Bearings describes with text, drawings, and photos, proper steps in demounting, cleaning, judging condition, and remounting of bearings. Booklet is issued by New Departure Div., General Motors Corp., Bristol, Conn.

Precision Tools 27

Henry Paulson & Co., Chicago, has prepared catalog of tools including line for aircraft precision work.

Cutting Equipment 28

Line of milling cutters, forming tools, and mills, reamers, and counterbores are pictured in operation in catalog of U. S. Tool & Mfg. Co., Dearborn, Mich. In mechanical drawing of each item, user can letter in his own dimensions and company will furnish price quotation.

AIRCRAFT

Universal Joints 29

Precision manufacture of universal joints for aircraft is traced by Dix Mfg. Co., Los Angeles, in booklet containing mounting instructions and specifications.

Propeller Tools 30

Line of tools made by Airplane Mfg. & Supply Corp., Glendale, Calif., for servicing Curtiss electric propellers is shown in company's catalog C.

● Announcements of new machine tools, shop equipment, and accessories are invited for inclusion in these columns. In writing, emphasis upon aviation industry applications of newly-marketed items is desirable, and wherever possible, glossy-print photos should be enclosed for illustration. Please do not send electros. Manufacturers should address New Products Editor, AVIATION, 330 W. 42nd St., New York City 18.

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NEW PRODUCTS

Instrument Approach 31

Report on 25 instrument landings with Douglas DC-3 are summarized in CAA Technical Development Report No. 32, *Instrument Approach Performance Characteristics on Radio Instrument Landing Systems.* This paper, by W. E. Ryburn of Aircraft Development Section, covers the UAL-Bendix system. Available from Government Printing Office, Washington.

Starters and Generators.....32

Literature distributed by Champion Aviation Products Co., Los Angeles, includes folders and sheets showing features, installations, construction, and engineering design of its aircraft starters and wind- and engine-driven generators.

Liquid Flow Measurement.....33

Fisher & Porter Co., Hatboro, Pa., has issued Catalog Section 63-G on its rotameters for measuring flow of fuel, oil, and de-icer fluid. Instruments are described and illustrated by photos, blueprints, and drawing of aircraft installation.

Airport Planning 34

Examples and locations of municipal airport facilities for small communities are considered in *What Your Town Needs in the Coming Air Age,* booklet prepared by Piper Aircraft Corp., Lock Haven, Pa.

Flexible Controls 35

Line of aircraft control cords, slings, and strand-and-wire swaged terminals and assemblies manufactured by new Aircord Div., John A. Roebling's Sons Co., Trenton, N. J., are presented in catalog containing specifications, performance graphs, and engineering drawings of construction features.

Hydraulic Fluids, Etc.....36

Whiz Aviation Products Div., R. M. Hollingshead Corp., Camden, N. J., is distributing Bulletin No. WM430 giving grades, descriptions, and uses of its products designed to meet government specifications. Items include hydraulic fluids, gasket paste, rust and corrosion preventive compounds, preservative lubricating oil, and aluminum soap grease.

Wing Jacks 37

Parts and operating features of various wing jacks to facilitate landing gear, strut, and undercarriage repair are pictured in bulletin released by Duff-Norton Mfg. Co., Pittsburgh.

Ring Maintenance 38

Data on piston ring design, manufacture, and maintenance has been collated in manual prepared by Muskegon Piston Ring Co., Muskegon, Mich. Shown are procedures of cleaning and inspection, fitting of rings, their dimensions and types, and there are specification tables on various makes of engines.

ELECTRICAL

Solderless Terminals 39

Terminal lugs made with pre-insulated sleeves are illustrated in folder which also has chart of dimensions available. Aircraft-Marine Products, Harrisburg, Pa., says bond to wire is made simply by slipping it under insulating sleeve and compressing joint with a small press and special die.

Aircraft Relays 40

Revised and enlarged catalog issued by Automatic Electric Co., Chicago, includes new line of small, light weight, vibration-resisting relays for aircraft and carbon and magnetic microphones designed especially for airport control rooms.

AN Fitting Chart 41

Range, dimensions, and part numbers of AN conduit fittings are listed in 12x18-in. wall chart available from Union Aircraft Products Corp., New York City.

Pilot Lights 42

Numerous types of pilot light assemblies—some with mechanical shutters—are pictured in Catalog No. 43 prepared by Dial Light Co., of America, New York City.

STEELS & PLASTICS

Steel Tubes 43

Picture story of manufacture of centrifugally cast steel tubes for engine parts and other items is contained in publication of American Cast Iron Pipe Co., Birmingham, Ala. Tubes, poured in revolving sand-lined molds, are supplied in nominal 16-ft. lengths with 3.46- to 50.11-in. o.d.'s. Inside diameters can be supplied as specified.

Molding Plastic 44

Standard Molding Corp., Dayton, Ohio, points out differences between injection and other types of plastic molding, use of injection in various products, and how this process is adaptable to precision mass production. Company's products and methods of manufacturing them are also shown.

MANAGEMENT & EMPLOYEES

Instruction Movies 45

Among motion pictures for employee instruction cataloged by Jam Handy Organization, Detroit, are several on fundamentals of electricity and machines, physics, drawing and drafting, pilot training, aviation mechanics and metalsmithing, and oxyacetylene welding.

Company History 46

Fiftieth anniversary of Elwell-Parker Electric Co., Cleveland, manufacturer of electric factory trucks, has been celebrated with publication of interesting, short, illustrated history, *Lengthened Shadows.*

Airlines 47

Economic analysis of past and future of air transport lines has been made ready for distribution by New York brokerage firm of Merrill Lynch, Pierce, Fenner & Beane.

Surplus Material 48

Material of all kinds and accessories not needed by AAF and available for purchase by industry has been cataloged with order blanks by 830th AAF Specialized Depot, Memphis, Tenn.

Machining Instruction Manual.....49

Specific steps, further clarified by illustrations, in operation and maintenance of screw machines are listed in operator's instruction manual issued by National Screw Machine Products Assn., Cleveland.

Production Inspirer 50

To stimulate workers' productivity and cooperation, Kollsman Instrument Div., Square D Co., Elmhurst, N. Y., has prepared booklet *Your Part in the War Effort* which tells them of principles, uses, and importance of company's altimeter in war flying.

Management Service 51

Services offered management by The Bedaux Co., New York City, in work measurement and production control, labor cost and expense control, job evaluation, and wage incentive systems are explained in booklet, *Production Management.*

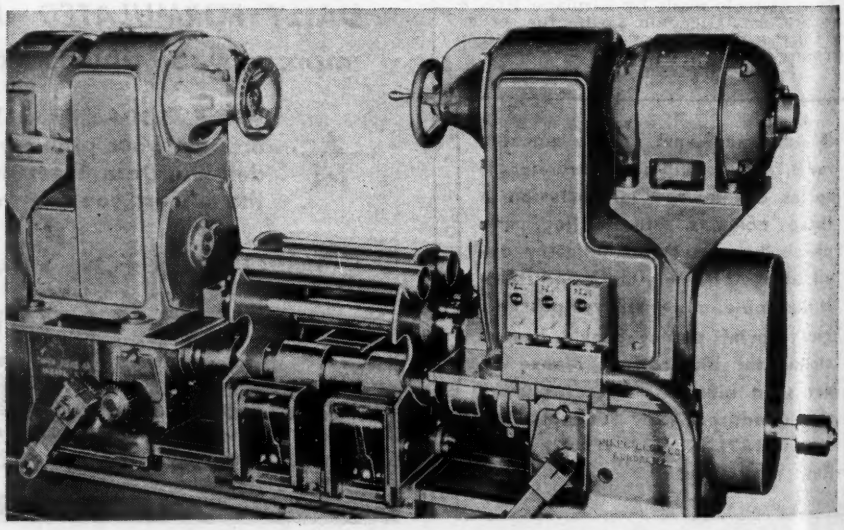
Tools, Wanted 52

L. M. Demarest & Associates, New York City, acting as broker for firms wishing to buy manufacturing equipment and businesses, lists following items for which there is now a market: Hydraulic pumps or fittings, piston rings, plastic molding machinery, and portable power tools.

Latest Machine Tools

Profiler Attachment 53

Pines Engineering Co., Aurora, Ill., announces addition of automatic reel-type feed mechanism to line of profilers for burring, boring, centering, facing, threading, turning, drilling, chamfering, or reaming one or both ends of rods and tubes simultaneously. Identical or different operations may be done on both ends of same tube at same time once feeder has placed it in self-centering chucks. In our illustration profiler has two chucks for tubes 24 in. long and 3 in. dia. They can be end-faced and chamfered simultaneously. Head and

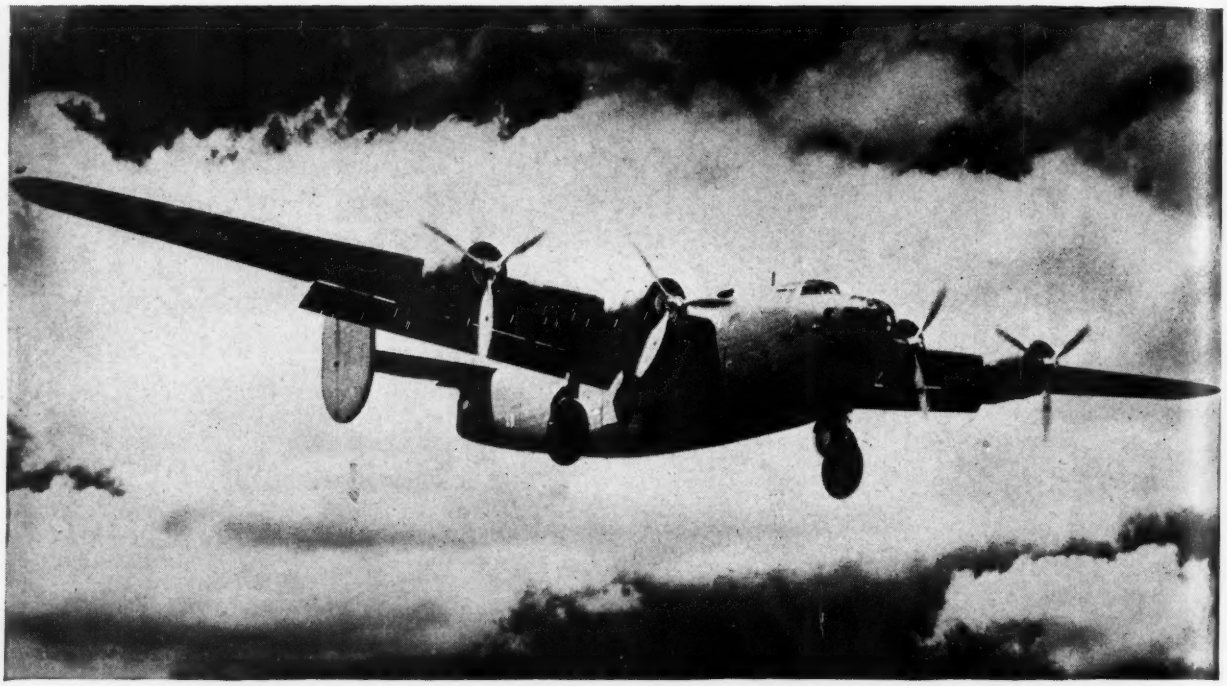


ON LIGHTER, STRONGER TIRES

UNITED STATES RUBBER COMPANY

1230 Sixth Avenue • Rockefeller Center • New York 20, N. Y.

WEIGHT OF CONSOLIDATED LIBERATOR ...Yet The Same Size U.S. Royal



HERE COMES 60,000 POUNDS OF BOMBER!

60,000 pounds of bomber... and what a bomber it is! From Ploesti to Rome and Berlin and from Guadalcanal to the Marshalls and the Gilberts, the enemy has felt the devastating weight of the destruction the Liberator carries.

In 1940, the B-24 was equipped with seven machine guns... four 30 calibre and three 50 calibre. A crew of six was required to operate her... and her total gross weight was rated at 41,000 pounds. Today, the Liberator is rated at 60,000 pounds gross with ten to thirteen 50 calibre machine guns operating in four power turrets, with a crew of ten, ten tons of bombs and far greater supplies of fuel and ammunition.

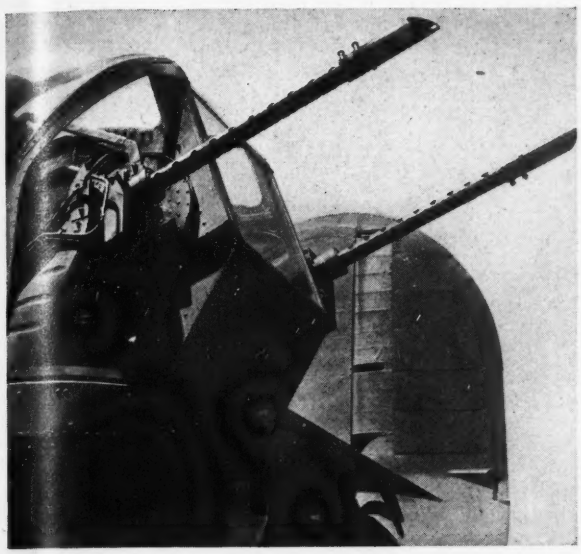
Even with this increase in load, the 56" tire size that equipped the original Liberator still does the job. Lighter, stronger U.S. Royal Rayon Cords replaced heavier, bulkier cotton cords. And today, more muscle, more strength to carry the thirty-ton load of the Liberator loaded for action are built into the new 56" "U.S." Nylon tires for the Army Air Forces.

• • •

Listen to the Philharmonic Symphony program over the CBS network Sunday afternoon, 3:00 to 4:30 EWT. Carl Van Doren and a guest star present an interlude of historical significance.

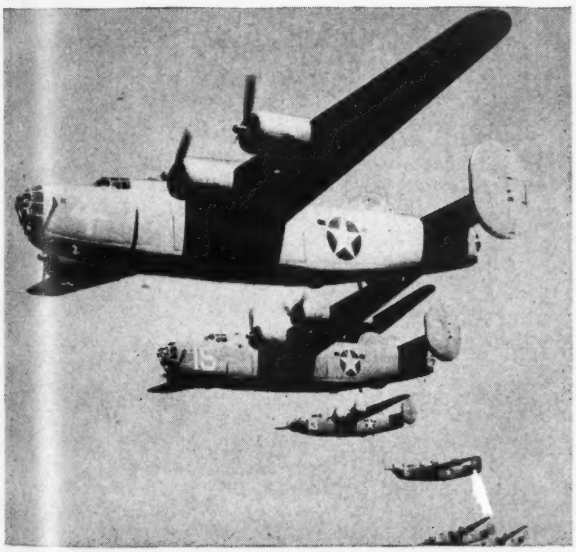
1230 SIXTH AVENUE **UNITED STATES**

INCREASED 19,000 POUNDS SINCE 1940
Airplane Tire Carries The Load!



MORE GUNS! When Consolidated introduced the Liberator, its armament consisted of four 30 calibre and three 50 calibre machine guns weighing 460 pounds. Today, the B-24 carries from ten to thirteen 50 calibre guns operating from four power turrets and weighing 900 pounds.

MORE BOMBS! As bombing missions have grown in intensity, the Liberator's bomb loads have increased so that today it carries ten tons of bombs tucked away in its belly to rain block-busting havoc on enemy objectives. Oil fields, railway yards, munitions plants have felt their destructive power.



MORE FUEL! Stored in bullet-sealing fuel cells in the wings and fuselage, the fuel supply of the Liberator gives it extra-long range. Fuel cells built by "U.S." fly with the B-24 in every war theatre—protect the greater gas supply against enemy gunfire.

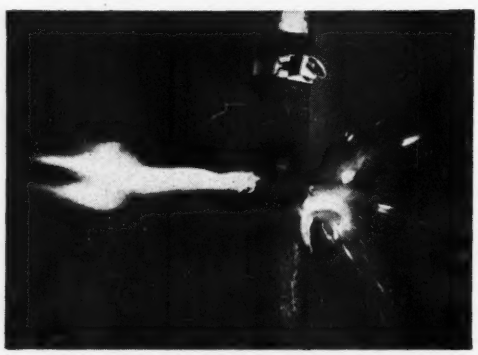
MORE POWER! The four engines of the B-24 of 1940 weighed 9,636 pounds. In 1944 the Liberator power plant including turbosuperchargers weighs 11,572 pounds. "U.S." Tires are lighter and stronger to carry the heavier load.

RUBBER COMPANY ROCKEFELLER CENTER, NEW YORK 20, N. Y.

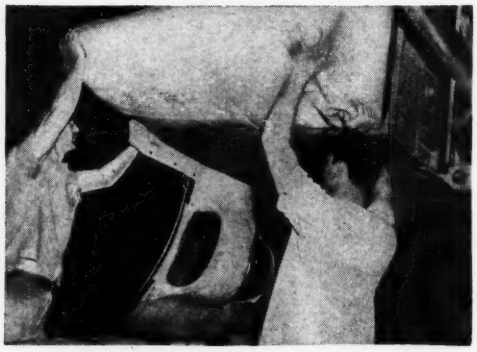
From Flying Boots to Fuel Cells ...From Boats to Block Tread Tires

FLYING BOOTS...When the altimeter points to 30,000 feet and better, the thermometer goes *way* down. That's when these extra-warm fleece-lined "U.S." Flying Boots really do their job.

LIFESAVING BOATS... Today, every Army and Navy bomber is equipped with inflatable rubber boats, many of them designed and built by United States Rubber Company.



FUEL HOSE... Even when drilled with enemy machine gunfire, this "U.S." Bullet-Sealing Fuel Hose heals the bullet wound, prevents loss of fuel and protects the plane and crew.



FUEL CELLS,..Hidden in the wings and fuselage, "U.S."-built bullet-sealing fuel cells protect the gas load of U. S. Army and Navy fighting planes against enemy gunfire.

U. S. ROYAL AIRPLANE TIRES...U.S. Royal Block Tread Airplane Tires take the shock of landing 60,000 pound Liberators and Flying Fortresses on every type of landing strip from emergency steel runway to desert sand.

These are only a few of the many United States Rubber Company products that have been developed with the help and cooperation of the Materiel Command, Army Air Forces and the Technical Staff of the Navy Bureau of Aeronautics. These products, many of them created in "U.S." laboratories, are today serving through science that men may live to build a better world.

SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

1230 SIXTH AVENUE · ROCKEFELLER CENTER · NEW YORK 20, N. Y.

chuck of left machine are adjustable on bed to accommodate material to 6 ft. long. Chucks will handle tubes or rods from ½ to 3 in. dia. Pines has also issued bulletin showing other model profilers, one for reaming and burring tubes up to 4 in. o.d. and 60 ft. long.—"AVIATION," Mar., '44.

Chrome Chamfers 54

Hard chrome plate to increase length of life is new feature of burr removing and chamfering tools designed to be set up in drill presses or other spindled machines. Tool which is kept in continuous action while operator feeds parts, consists of cylindrical piloting shaft with

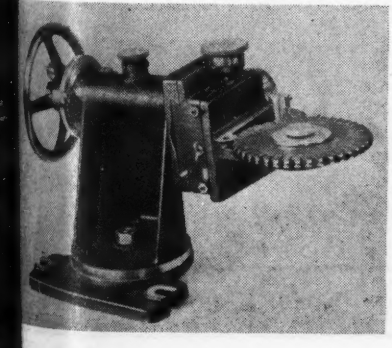
a knurled collar attached to one end. Collar has free-rolling ball bearing that can be held in hand while shaft rotates. Burring blade can be advanced into cutting position or withdrawn by sliding collar up or down. Nobur Mfg. Co., Los Angeles, is maker.—"AVIATION," Mar., '44.

Lever Chuck 55

General Die-Stamping-Tool Co., New York City, announces development of "Lever-Type Speedichuck" to increase collet capacity of ½-in. lathes to ¾-in. It permits work to be chucked, fed, machined, and released while lathe is in motion and can be attached to standard lathes without drilling or tapping. Floating closing sleeve compensates for spindle misalignment.—"AVIATION," Mar., '44.

Grinding Fixture 56

Hill-Bartelt Machine Co., Rockford, Ill., announces radius grinding fixture for profile grinding, on standard machines, of milling cutters from 3 to 6 in. dia. and up to 1 in. thick along arc extending to 180 deg. With fixture clamped to table of grinder, cutter is clamped to a rotating plate on right of head. Wheel at opposite side of fixture, swings plate (and cutter) to desired arc. By means of micrometer adjusting screws on cross slides, cutter



Castolin Eutectic

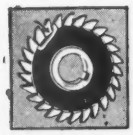
EUTECTIC*

(Means Lowest Binding Alloy)

LOW TEMPERATURE WELDING

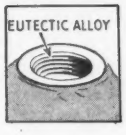
WHY EUTECTIC IS THE FASTEST GROWING WELDING ROD (for oxy-acetylene, metallic arc, etc.) IN AMERICA

The acceptance gained by Eutectic Low Temperature Welding Alloys in two short years is unmatched in the Industry. The reason—Eutectic Low Temperature Welding (for salvage, maintenance and production) offers advantages never before combined in any welding process.



HIGH STRENGTH

Eutectic joints equal or surpass parent metal in tensile strength . . . 2 to 3 times stronger than brazing or soldering.



PERFECT MACHINABILITY

Eutectic Alloys bind at safe, lower temperatures, thus eliminating stresses, distortion, brittleness.

MATCHING COLOR

With Eutectic you can have undetectable, color matching welds . . . another advantage over brazing. (Important for salvage)

ALL-AROUND ECONOMY

Thin flowing Eutectic Alloys give stronger joints without fillets . . . Lower temperatures are reached faster and preheating is reduced. Smooth joints eliminate after-machining.

INVESTIGATE EUTECTIC TODAY

Do you weld cast iron, steel, alloy steel, aluminum, brass, bronze, copper, nickel, nickel alloys, Dow-metal? . . . One of 43 Eutectic rods will do a better job and effect considerable economies in your plant.

*Eutectic & Low Temperature Are Reg. U. S. Pat. Off.

EUTECTIC WELDING ALLOYS COMPANY

Originators of the Low Temperature Welding Process

40 Worth Street • New York 13, N. Y.

EUTECTIC WELDING ALLOYS CO., 40 Worth St., N. Y. 13, N. Y. Dept. S-3

Please send me:

☐ 8 p. Booklet on Eutectic Tool Salvage Instruction Poster

☐ 36 p. Eutectic Data Book

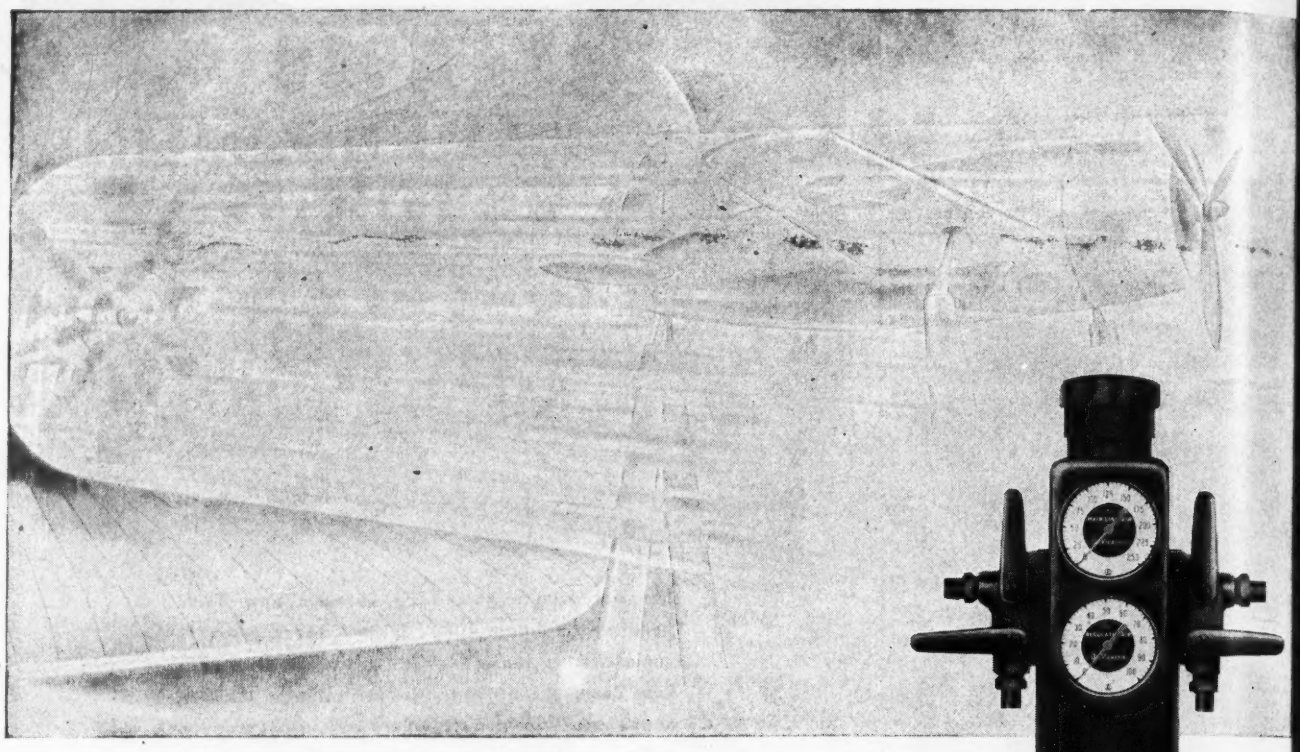
☐ Instructive House Organ

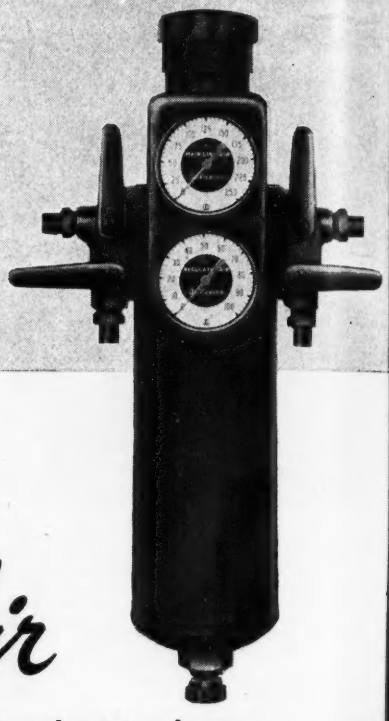
Name.....

Company..... City.....

Address.....

A PIONEER IN MAKING AIR SERVE THE AVIATION INDUSTRY





Experience in *Tailoring Air*

to exact measurements for applying materials from wing fabric cement to engine cleaning solvents

● DeVilbiss has a record of air achievements, too —on the ground. They are the result of over 56 years of leadership in the handling and compressing of air. Today the Aviation Industry is using these DeVilbiss achievements to help win the Battle of the Skies.

One of the important phases of DeVilbiss air research and engineering has been in the *cleaning and exact regulation of compressed air.* From this has come a line of DeVilbiss Transformers which deliver clean, moisture-free air at correct pressures for many operations, from spraying camouflage paint on flying boats to applying caulking compound to wing and fuselage seams.

DeVilbiss engineering know-how in *compressing, cleaning, controlling, transmitting* and *using* air has developed an extensive line of other air-operated and air-handling equipment that serves Aviation in countless ways. Compressors that furnish a reliable, low cost air supply. Guns that spray everything from solvents to cements. Exhaust systems that improve working conditions. Hose and Connections that convey anything from air to grease.

Let DeVilbiss' years of air experience show you how air can be of greater service to you. Ask a DeVilbiss field engineer for his suggestions.

THE DEVILBISS COMPANY, TOLEDO 1, OHIO
Canadian Plant: WINDSOR, ONTARIO

DE VILBISS
Spray Systems

SPRAY EQUIPMENT • EXHAUST SYSTEMS • AIR COMPRESSORS • HOSE & CONNECTIONS

MACHINING *Ceramics* IS NO PROBLEM

Cutting a coil form on a Walker-Turner Radial Saw; equipped with a special attachment for rotating the workpiece.

WHEN YOU USE WALKER-TURNER MACHINE TOOLS

At General Ceramics and Steatite Corporation's plant, Walker-Turner Machine Tools are used on a variety of jobs — in machining the Steatite insulators which this Company manufactures for the High Frequency Communication Equipment used by our Armed Forces.

Walker-Turner Machine Tools' *wide range of speeds* enables General Ceramics to select the optimum speed for their particular work. Their *accuracy* and *spindle stability* are important because Steatite is machined in its green, fragile condition before firing. And their *simplified design* and *easy operation* help this Company's many women workers turn out a greater volume of high-quality work.

In thousands of other war plants, also, Walker-Turner Machine Tools are doing a notable job in getting production "over the hump". Perhaps they are the answer to some of your machining problems, too. Send for catalog.

WALKER-TURNER COMPANY, INC.
1234 Berckman St., Plainfield, N. J.

One of several groups of Walker-Turner Drill Presses in the General Ceramics plant. These machines are used in drilling and tapping insulators of all types.

walker-turner
COMPANY, INC.
PLAINFIELD, N.J.
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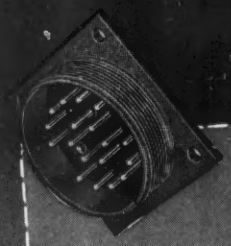
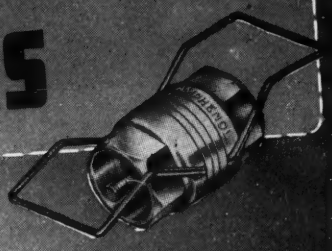
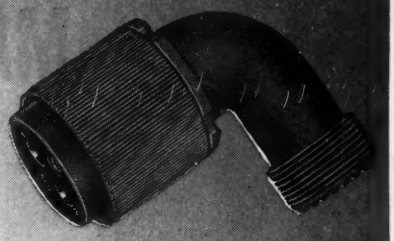
MACHINE TOOLS

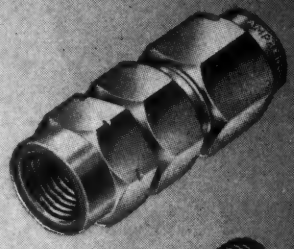
DRILL PRESSES — HAND AND POWER FEED • RADIAL DRILLS
METAL-CUTTING BAND SAWS • POLISHING LATHES • FLEXIBLE SHAFT MACHINES
RADIAL CUT-OFF MACHINES FOR METAL • MOTORS • BELT & DISC SURFACERS

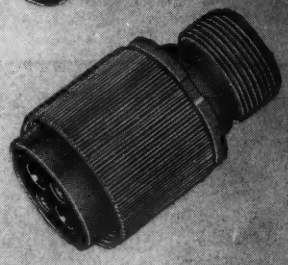


BRITISH TYPE ELECTRICAL CONNECTORS





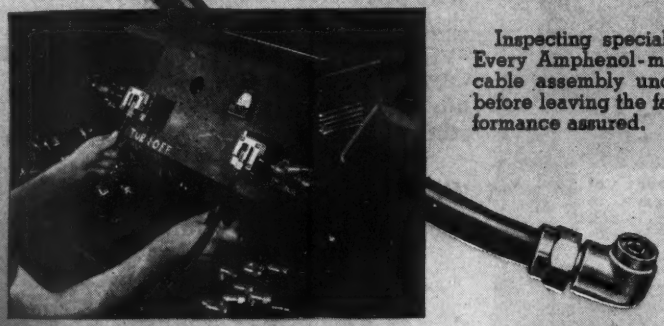




• Amphenol produces British Type Electrical Connectors to specifications developed by the British Air Ministry. These connectors are used to facilitate the production and installation of certain types of British aircraft, marine, and radio apparatus made in America.

Threads are accurately machined to British Whitworth Standards. The same careful workmanship and engineering go into British Type Connectors that is representative of the complete Amphenol line.

BRITISH TYPE:
PLUGS AND RECEPTACLES
for electrical circuits.
PLUGS AND SOCKETS
for coaxial cables.
FITTINGS AND END CAPS
for electrical connectors.



Inspecting special wiring assembly. Every Amphenol-made connector and cable assembly undergoes rigid tests before leaving the factory. Efficient performance assured.

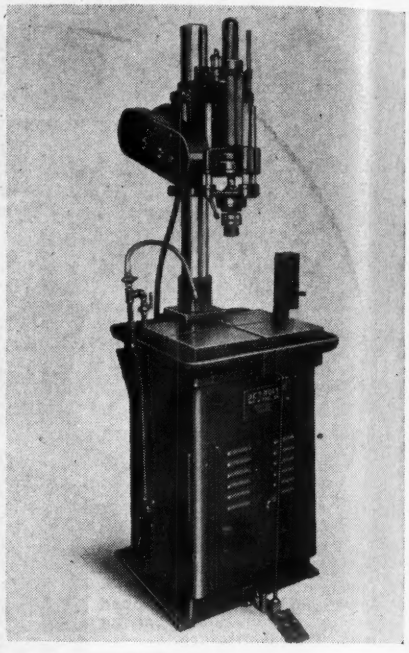
AMERICAN PHENOLIC CORPORATION, CHICAGO 50, ILLINOIS
IN CANADA—AMPHENOL LIMITED • TORONTO

Send today for illustrated data sheets on British Type Electrical Connectors. Complete specifications—10-page listing of items, parts, and assembly instructions.

can be positioned so that center of arc to be ground will fall along axis of shaft on which head is rotated. A scale, marked in degrees, on base of pedestal provides adjustment of angle at which tooth is presented to grinding wheel, thus determining back-off angle. Indexing is manual. Arc scale on back of head shows amount of swing. Side cutting teeth may be ground when cutter is put in fixed position. After radius has been ground, other regular operations can be done without removing cutter from fixture.—"AVIATION," Mar., '44.

Screw Tappers 57

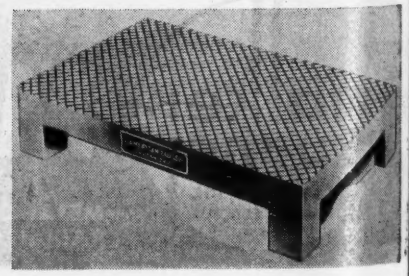
LTM series of light duty lead screw tapping machines has capacity of 7/8 in. dia. and 14 pitch in mild steel. For accuracy, spindle is guided throughout its stroke length by rods, and a movable



head guides driving end of spindle. Spindle can be driven between tap and lead screw itself, thus reducing possibility of inaccuracies resulting from lead screw wind-up. Loosening one screw and dust cap permits removal of interchangeable lead screw and bronze lead nut. Nut can be adjusted to take up wear and backlash. Accommodation of work of various sizes is provided by worm gear which raises head and motor and permits them to swing through 90 deg. arc. Interchangeable V-belt pulleys supply spindle speeds of 64, 160, and 400 rpm. Motor has adjustable mounting for changing and compensating belts, and its drive has friction clutch with hand control for tension setting. Trips on limit switches can be set for any length of stroke, thus providing cycle which descends proper distance, reverses, and then stops. At any point of cycle, tap can be controlled by emergency stop and reverse push buttons. Standard square table, provided by **Detroit Tap & Tool Co.**, Detroit, has T-slots.—"AVIATION," Mar., '44.

Lapping Plate 58

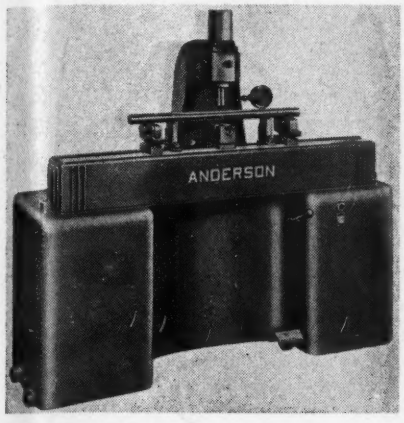
Designed to give superior cutting action, new lapping plate announced by **American Gauge Co.**, Dayton, Ohio, has grooves spaced ¼ in. apart, at right



angles to each other, and at 45 deg. to center line of plate. Cast iron block, of special fine grain, is 1⅛ in. thick and is mounted on four legs. Surface is first ground, then lapped until accurately flat, and 1/16 in. wide grooves are cut deep so surplus lapping compound will not accumulate on plate surface. Plate is 8 in. wide, 12⅛ in. long and 2½ in. high.—"AVIATION," Mar., '44.

Straightening Press 59

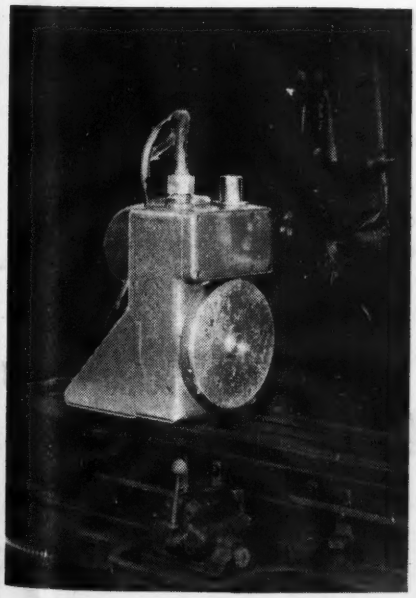
For straightening shafts and rods as little as .001 in., Anderson Bros. Mfg. Co., Rockford, Ill., is marketing hydraulic press of 10-ton capacity. At eye level at right is gage showing downward pres-



sure of ram, and below ram is adjustable dial indicating amount of shaft runout in pre-, full-, and unloaded positions. Control lever, hip-high at right, regulates pressure delivered to ram through rotary valve after push button is in operating position. Pressure applied to work increases as lever is depressed.. When released, it springs back to off position and ram returns. Work table is 60 in. long. Stop collar will limit maximum ram stroke to 6 in. Available accessories include equipment for foot-operation, as well as checking rolls, spring-loaded centers, and adjustable anvils.—"AVIATION," Mar., '44.

Index Bases for Millers..... 60

Sundstrand Machine Tool Co., Rockford, Ill., is marketing two sizes of automatic index bases for use with its milling machines. Bases, which can be mounted in vertical or horizontal positions (former illustrated), have been designed with tables of 8 and 12 in. dia. They are sealed against dust, chips, and oil, and can be employed in dry milling. In vertical position, they can be used with tailstock for milling splines, keyways, and slots. Horizontally and without reposi-



Get these
Extra Advantages
of
AMPHENOL
DESIGN
in all your
"AN"
CONNECTORS

ALL REQUIRED STYLES.
ALL REQUIRED SIZES--

● Amphenol A-N Electrical Connectors often exceed maximum Army-Navy specification requirements in engineering design and construction. The "extras" built into Amphenol A-N Connectors give them greater dielectric strength, easier wiring assembly, more positive connect and disconnect, less possibility of shorting or mechanical failure.

● Amphenol insert elements have heavier sections—greater thickness—greater strength.

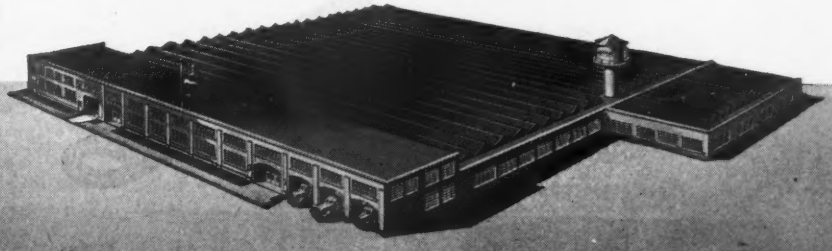
● Amphenol A-N Connector Inserts are provided with barriers to increase insulation between contacts.

● Contact designations are molded on front and back of insert elements for quick identification.

● Large size contacts, including 8, 4 and 0, held in inserts by special locking arrangement—fast, easy removal for soldering.

OTHER AMPHENOL PRODUCTS

A-N Electrical Connectors are only a part of the extensive Amphenol line which serves the electronics industry. Other products include: A-N Conduit, A-N Conduit Fittings, Low-Loss Cables and Connectors, British Type Connectors, Connectors for special Applications, Radio Parts and Accessories, Synthetics—Sheet, Tube, and Rod.



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CHICAGO 50, ILLINOIS

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The tool that replaces the torch...

IT'S the Burndy HYTOOL . . . the easy-to-use indenting pliers which *indent* Burndy HYDENT connectors to wires merely by closing the jaws. It makes a small wire electrical connection quicker, *surer and stronger*, than by any other method.

Burndy HYDENT connectors, are *one-piece, pure copper* connectors. Thus, when firmly indented to wires with the HYTOOL, they provide connections of *maximum conductivity*, that are *on to stay!*

For electrical maintenance, as well as in manufacture, you can *lower installation and servicing costs*, and *improve circuit efficiency*, by using the HYTOOL instead of the torch. Why not send for the new HYDENT catalog, today?

Burndy HYDENT Connectors are available for all wire and cable sizes from #30 to 2500 mcm . . . and in types for all connection problems.

Burndy Headquarters for CONNECTORS

BURNDY ENGINEERING CO., INC.
107 EASTERN BOULEVARD, NEW YORK 54, N. Y.

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. . . the mark of a sound and efficient electrical connection!

Specializing in AN Hex Head Aircraft Bolts, Cleveland is producing millions of bolts with or without drilled shanks and heads, in all standard sizes. Made to Army and Navy specifications, of course, but with the extra strength added by Kaufman Process manufacture... Many of your specially designed parts and fasteners can be made now to better advantage by our improved cold forming methods. It pays you to let us check your specifications for "specials."

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CASTERS & WHEELS

Precision-made Darnell Casters with the DOUBLE BALL-BEARING SWIVEL assure a long life of efficient, economical service

They reduce the overhead that is underfoot and materially increase employee efficiency

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tioning of parts, index permits loading of one part while another is being finished. Movement of milling machine table on which index is mounted operates limit switches, resulting in automatic clamping and unclamping before and after cut, automatic indexing to each station, and automatic stopping when desired number of indexes are completed. Indexing plunger registering in notches cut in master plate provides spacing to within .001 in. on periphery of index base top plate. Master and mask plates determine selection of indexes; 12 in. size has 36 indexes, the 8 in. 24. Special combinations can be furnished for spacing combinations below 36. Other bases are available for tables of 18 and 24 in. dia., and spacing combinations can be provided on order.—"AVIATION," Mar., '44.

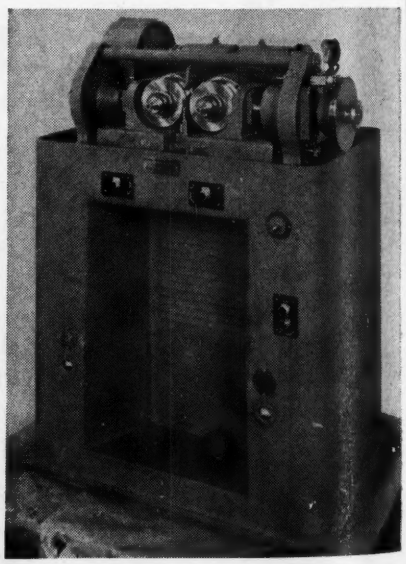
Die Cushion 61

Mountable on practically any power punch press, self-contained die cushions have hardened and ground pin pressure pad that can be machined to fit required press bed openings. Besides their application controlling ring in deep drawing, these pneumatic cushions, say **Dayton Rogers Mfg. Co.**, Minneapolis, can be used on pressure pads on many forming dies. Models are made in sizes of 6 to 24 in. with drawing capacity of 2 to 12 in.; they will develop ring holding pressures of 1½ to 23 tons on 100 lb. air pressure. Accessories supplied include combination reducing regulator and valve, pressure gage, and hose fittings.—"AVIATION," Mar., '44.

Thread Roller 62

New principle is utilized in machine for cutting outside threads on bolts, screws, and studs of alloys, steels and light metals. Work blank, machined to pitch diameter, is placed in machine between large diameter rolls faced with negative multiple threads of desired profile, pitch and helix angle. Rolls are applied to work with hydraulic pressure, cutting all threads simultaneously as material turns on its axis.

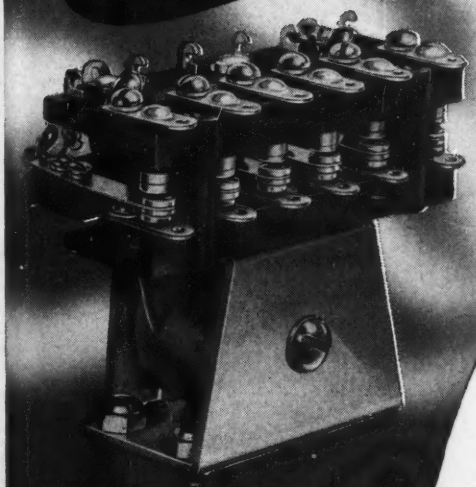
When proper pitch diameter is obtained, pressure is released by automatic control which can be set by micrometer adjustment; rolls then return to starting position automatically. Class 4 fit accuracy is produced by machine, says **W. A. Schuyler**, New York City, sales agent for manufacturer, Watson-Flagg Machine Co., Paterson, N. J. Threads of all standards can be rolled on hollow bodies, tubes, shafts, or spindles. Capacities are ⅛ to 1 in. on high tensile strength steels and up to 2½ in. on ordinary steels; thread length is up to 2¾ in. Driving mechanism consists of 5 hp. motor, V-belts, and double set of worm gears. Oil pressure pump is operated by separate motor, and all driving parts—including coolant pump, tanks, and filters—are enclosed in machine base.—"AVIATION," Mar. '44.

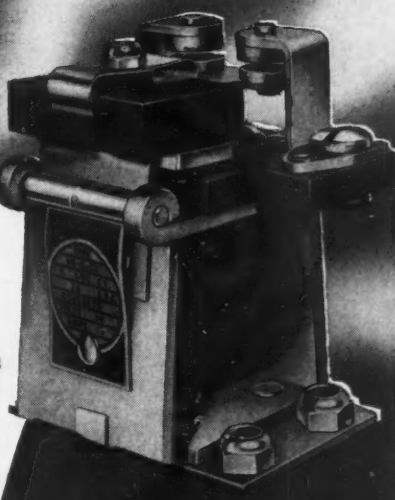


Power Twins

of

ALLIED'S RELAY LINE





BN 18...

...the multiple circuit Power Relay; six pole — double throw, handles loads of 10 amperes per contact at voltages to 32 DC and 115 AC non-inductive on low power consumption of only 3.5 watts. Its coil is cellulose acetate sealed against humidity and salt-spray (an exclusive and patented feature of Allied Relays). Dimensions are 2 9/16" high, 3" wide and 2 1/8" deep. Weight is 9 1/2 ounces.

RUGGED...

in their design and construction to withstand shock, vibration and extreme temperatures; built for heavy and continuous duty under most severe operating conditions.

DEPENDABLE

for aircraft, marine and industrial applications such as circuit breaking, switching, motor starting, motor controlling and for overload protection.

SPECIFY...

Allied's power-twins for all relay applications where positive action, long life and the utmost in dependability are desired.

AN and ANS...

...the heavy duty Power Relays. Standard contact arrangement is single pole—single throw—normally open—double break. AN handles loads to 50 amperes—ANS to 75 amperes—at voltages to 32 DC and 115 AC non-inductive on low power consumption of only 3.5 watts. Their coils are cellulose acetate sealed against humidity and salt-spray (an exclusive and patented feature of Allied Relays). Dimensions are 2½" high, 2¼" wide and 2" deep. Weights are 9 ounces each.

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INCORPORATED

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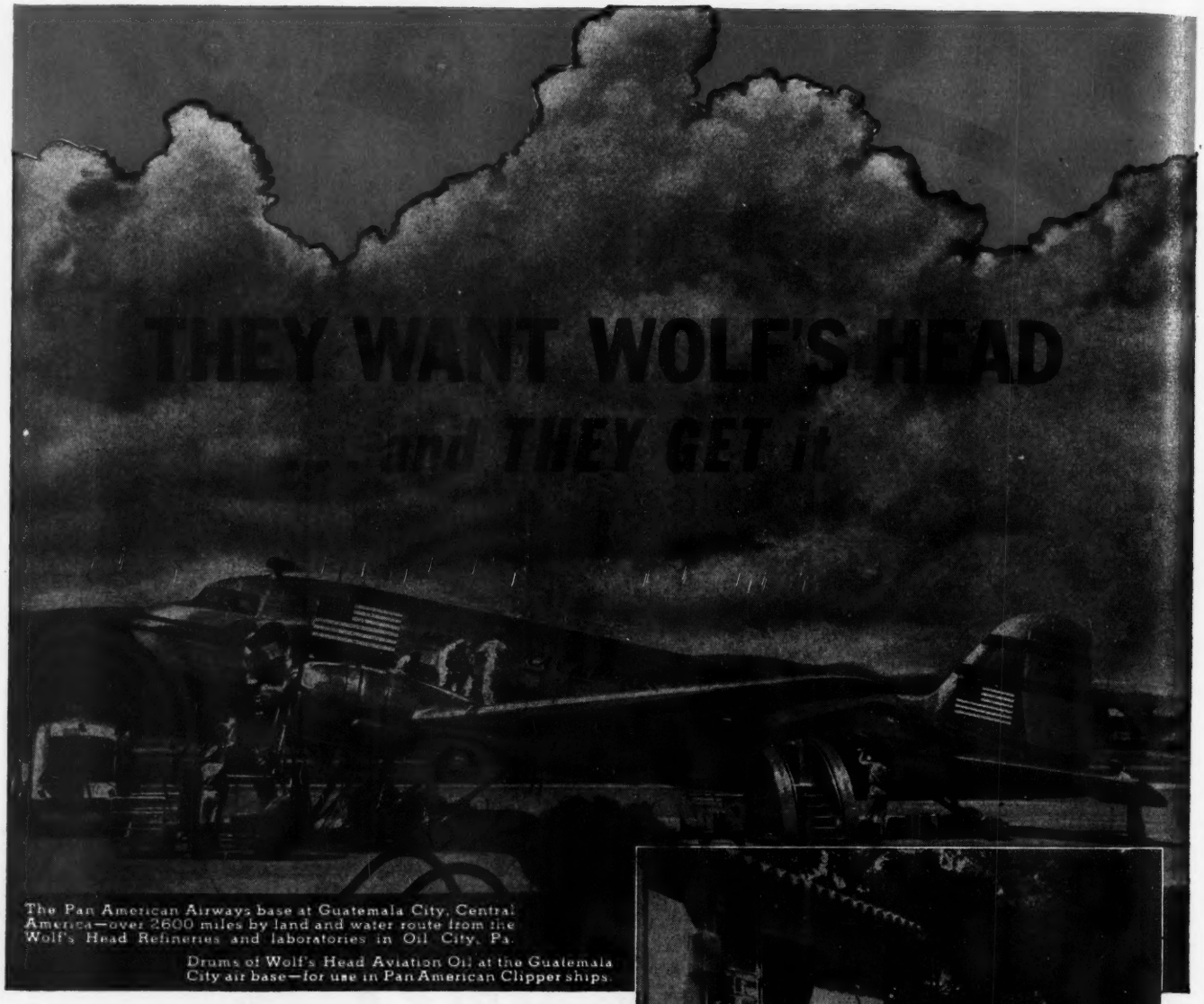
FACTORIES: NEW YORK CITY • PLANTSVILLE, CONN. • CHICAGO, ILL.



The Pan American Airways base at Guatemala City, Central America—over 2600 miles by land and water route from the Wolf's Head Refineries and laboratories in Oil City, Pa.

Drums of Wolf's Head Aviation Oil at the Guatemala City air base—for use in Pan American Clipper ships.

Cargo space is precious in these war times, but Pan American World Airways is asking for Wolf's Head Aviation Oil—and *getting it regularly*—at the Pan American air base in Guatemala City, Central America—over 2600 miles away.

Wolf's Head is also shipped to this air-transport company's vast network of air bases throughout South America—far beyond Guatemala City.

Further evidence that Wolf's Head Aviation Oil—made from Pennsylvania's finest crude, and engineered to aviation use—has the superior lubricating qualities necessary to withstand the tremendous heat and compression developed by the modern high-speed multiple-motored plane and Clipper ship!

Pan American's satisfaction with Wolf's Head is emphasized by the fact that they have flown more than *one billion* passenger-miles with this oil. *Wolf's Head Oil Refining Company, Inc., Oil City, Pa.—New York 10, N. Y.*

WOLF'S HEAD

100% PENNSYLVANIA

AVIATION OIL

P.G.C.O.A. Permit No. 6

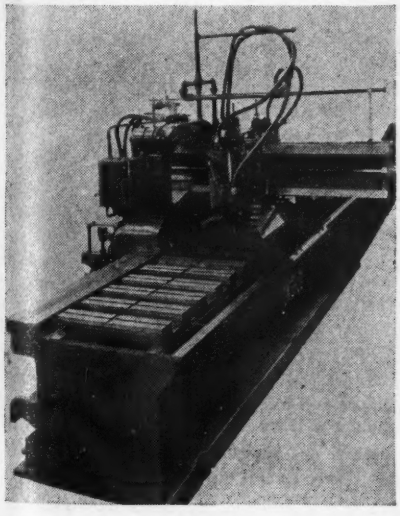
Collet Chuck 63

Wedge lock to prevent slipping when working on aluminum or hard alloy steel and to hold material several thousandths of an inch under- or oversize are features of Armor collet chuck, for small lathes now being mass-produced after nearly a year's experimental machine shop trials. Forced against stop, stock is held by

draw-back and push-out action making for accurate length. Since chuck revolves with spindle, reports **Aircraft Machinery Corp.**, Burbank, Calif., no heat is generated, and bearings and lubrication are not needed. With full spindle capacity, chucks come in round, square, and hexagonal types. Adapters are manufactured for most types and sizes of collets.—"AVIATION," Mar., '44.

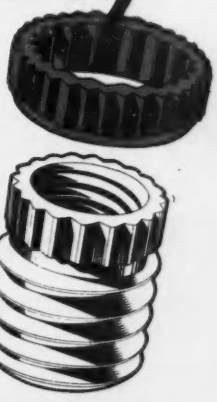
Sheet Stock Beveler 64

Onsrud Machine Works, Chicago, announces installation in aircraft factory of machine for beveling wing and fuselage sheet stock in cuts up to 8-in. wide with resulting surface flatness of .0001 in. Work is laid on bed (which has T-slots), and two cutter heads, each of which can be tilted to 15 deg. off perpendicular, travel along on carriage. Motors of 15 hp. drive end mill or fly type cutters at 3,600 rpm. With 15-in bed, machine shown can make bevel 110 in long with one cutter, or one 78 in. long with both; extra bed sections can be added for longer cuts. On cross cutting, work is



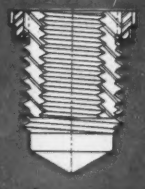
tilted to desired angle, and cutter head, held in vertical position, moves across bridge arm screw; maximum crosswise 90 deg. edge travel is 30 in. Work is held in position during cutting by vacuum chuck. "AVIATION," Mar. '44.

This Ring LOCKS

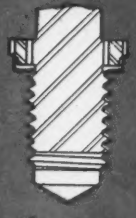


ROSÁN THREADED INSERTS AND LOCKED-IN STUDS IN ALL MATERIALS

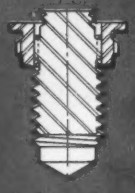
THE ROSÁN LOCKING SYSTEM



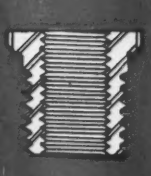
ROSÁN STANDARD INSERT



ROSÁN STANDARD STUD



ROSÁN TERMINAL STUD



ROSÁN ONE-PIECE REPLACEABLE INSERT

Under the Rosán Locking System, Rosán Threaded Inserts and Studs are completely permanent installations, yet they are easily removed.

• **STANDARD INSERT.** The Rosán Threaded Insert, when locked in another material, owes its permanence to the Rosán Locking Ring. When forced into the counterbore around the serrated collar this ring broaches the parent material with the sharp leading edges of its outer serrations or splines, and locks the unit solidly in the material.

• **STANDARD STUD.** The Rosán Locked-in Stud uses the same type of locking ring as used on the Threaded Insert. Any amount of force may be applied to a frozen nut without disturbing the stud. As it cannot back out, no oversize replacement is ever necessary.

• **TERMINAL STUD.** This stud may be put in from the front; requires no through-boring, recessing or shielding at the back. Although this stud is locked in the material it is easily removable for repairs or replacement without disturbing the panel and without injury to the parent material.

• **MOLDED-IN INSERT.** Used for plastics and other molded materials which require stronger fastening points than are possible in these materials direct. Removal leaves a threaded, counterbored and serrated hole into which a standard Rosán Locked-in Insert may be installed without extra operations.

WRITE for Special Bulletins describing the above Inserts and Studs. Please state your title when writing. Manufacturers are invited to submit their fastening problems to our Engineering Dept. No Obligation.

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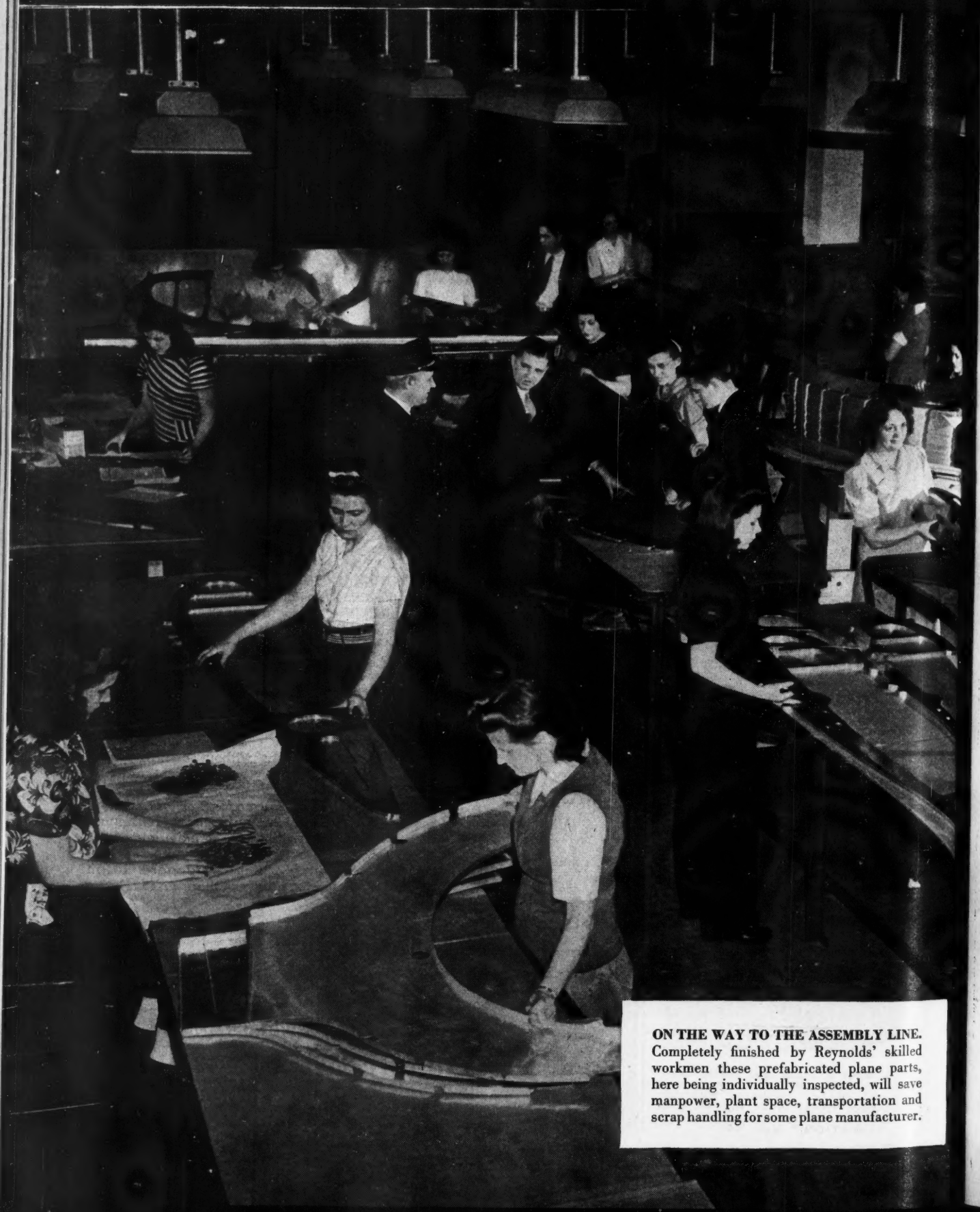
BARDWELL & McALISTER, INC.

Dept. 3-24—Box 1310, Hollywood 28, Calif.

Thousands of man-



ON THE WAY TO THE ASSEMBLY LINE. Completely finished by Reynolds' skilled workmen these prefabricated plane parts, here being individually inspected, will save manpower, plant space, transportation and scrap handling for some plane manufacturer.

r-hours SAVED...

by Prefabricated Plane Parts Service . . .
Pioneered by REYNOLDS

HERE'S one answer to your manpower shortage. An answer that's already saving thousands of precious man-hours of airplane labor for every leading manufacturer of combat planes.

Under this plan, pioneered by Reynolds only 3 years ago, completely finished parts come to your production lines ready for immediate assembly. No longer is it necessary to tie up valuable plant space with large stocks of aluminum sheet or die-cutting and forming machines.

All of this is done for you, at the Reynolds plant, by workmen skilled in the prefabrication of the parts you use. Men in your plants who would ordinarily fabricate these parts can be used on assembly lines and in other important jobs.

Big savings in scrap handling realized

The Reynolds prefabricated plane parts service also does away with scrap handling. Aluminum scrap, which averages 30% of every sheet, is immediately re-rolled into prime sheet, then prefabricated into more new parts, practically overnight. There is no needless cross-shipping of scrap. In figuring prices on parts, Reynolds allows plane manufacturers full price for scrap accumulated, thus saving entire cost of handling.

It is this kind of progressive thinking and co-operative planning that has resulted in an organization which now operates 40 plants in 14 states, and continues to grow by leaps and bounds. For Reynolds men are not satisfied to have been the first to supply finished plane parts from aluminum sheet. They have given themselves the continuous job of finding new ways to make aluminum better . . . easier and cheaper to use.

That's why you'll find Reynolds' resources, equipment and engineering skill can be of assistance in helping you with your aluminum problems, *no matter what they may be.* Reynolds Metals Company, Aluminum and Parts Divisions, Louisville, Ky.

REYNOLDS

The Great New Source of

ALUMINUM

INGOT · SHEET · EXTRUSIONS · WIRE · ROD · BAR · FORGINGS · TUBING · FOIL · POWDER

WHEN REPAIR CREWS *Take Over*

They're doing a great job—repairing damaged planes and other fighting equipment at front line bases. For operating riveters and other equipment, air compressors are powered by sturdy, dependable air-cooled-gasoline engines. One more front line duty for the hundreds of thousands of Briggs & Stratton engines now "In Service".

Just as Briggs & Stratton engines have been war-proved, so have our facilities for manufacture. The way those rugged, dependable engines have come through with flying colors is definite proof that Briggs & Stratton high standards of quality materials and precision manufacture could be, *and are being* maintained in face of wartime production schedules.

Our engineering and production staffs are geared up to help you on present war needs, or on your planning now for future production of gasoline powered equipment.

"It's powered right — when it's powered by Briggs & Stratton."

BRIGGS & STRATTON CORP.
MILWAUKEE 1, WISCONSIN, U.S.A.

BACK THE ATTACK
BUY WAR BONDS

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

Floating Tool Holder..... 65

More perfect correction of off-center and out-of-parallel misalignment is reported advantage of new floating tool holder which consists of only five component parts. Moving parts ride on rollers allowing self-adjustment of float in any direction. Maker, **Empire Tool Co.**, Detroit, says that holder permits close-tolerance reaming to absolute size and perfect roundness and minimizes maintenance. Body is manufactured in two sizes, 2½ and 3 in. Former has ½, ¾, and 1-in. holes and shanks of 1, 1¼, and 1½ in. Respective dimensions of latter are 1, 1¼, and 1½ in. and 1¼, 1½, 1¾, 2, and 2¼ in.—**"AVIATION," Mar., '44.**

Tap Reconditioner..... 66

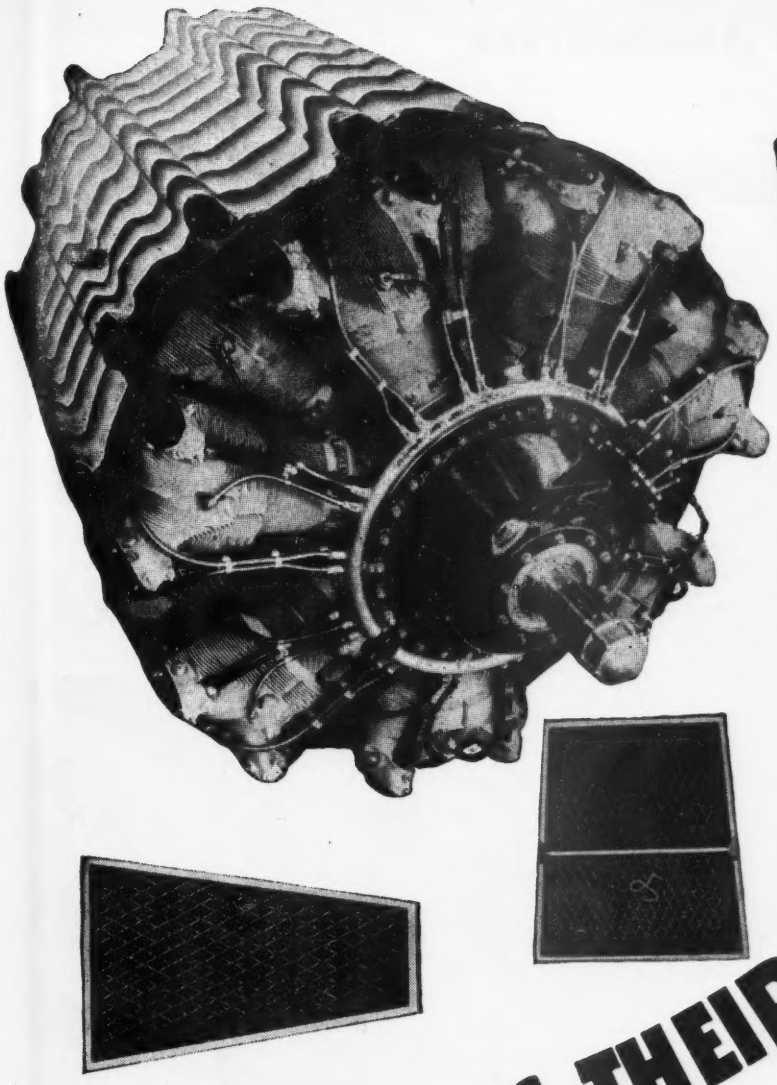
Principal changes in newly designed tap reconditioner are spindle head to accommodate motors for various power supplies and improvement in tap chamfering unit facilitating changing of taps and collets. Tap chamfer, located on left side of machine, will take collets from smallest machine screw size up to 1¼ in. standard tap shank. Mounting of spindle

assembly on dove-tail ways in the pedestal base has produced high degree of rigidity in spindle head and adjustability for grinding tool wear. Spiral pointing, with power supplied by new spindle, and spiral point polishing operations can be performed by integral units of the machine, says **Detroit Tap & Tool Co.**, Detroit. Wiring is internal, and a line switch is incorporated in machine base. Manual switch, also in base, controls ½-hp. spindle motor, available for power source of 220 or 440 v. three-phase and 110 v. single phase on either 25 or 60 cycles.—**"AVIATION," Mar., '44.**

Steady Rest..... 67

To be used in engine or turret lathes on second operations on propeller parts and other aircraft pieces, new self-centering steady rest has been designed by **Charles Stecher Co.**, Chicago. Two models are available: One, hand operated with capacity of 1½ to 9 in. for direct mounting on ways of 22-in. lathe; other, run by air, has bracket for mounting on back of turret lathe thus allowing front clearance for side turret. Interlocking arms, for supporting cylindrical parts, move on steel rollers and bearings. Spring tension and dial indicator are provided with clamping screw to insure uniform pressure on pieces of varying diameter.—**"AVIATION," Mar., '44.**

• Announcements of new machine tools and shop equipment and accessories are invited for inclusion in these columns. Manufacturers should address New Products Editor, AVIATION, 330 W. 42nd St., New York 18, N. Y.



INCREASING THEIR FIGHTING LIFE 10 TIMES!

Airplane engines protected by AAF intake filters operate efficiently in actual fighting service without overhauling for 300 to 400 hours—about *10 times as long* as engines not equipped with filters!

Dust clogged motors just won't respond when the pilot's very life depends on split-second twisting, turning or dodging an enemy. AAF filters successfully fight the engine's arch-enemy—dust—on every front. Further, by cutting down on wear, they reduce gas and oil consumption and save priceless replacement parts.

Today we are making more than 20 types of special AAF engine filters for United Nations planes—and are proud to contribute to the Allies' magnificent success in the air.

AMERICAN AIR FILTER COMPANY, INC., Louisville, Ky. • *In Canada:* DARLING BROS., LTD., *Montreal, P. Q.*
***Address* 346 Central Ave., Louisville**

KEEP UNITED NATIONS PLANES FLYING LONGER

AMERICAN AAF AIR FILTERS

AIRPLANE ENGINE FILTERS

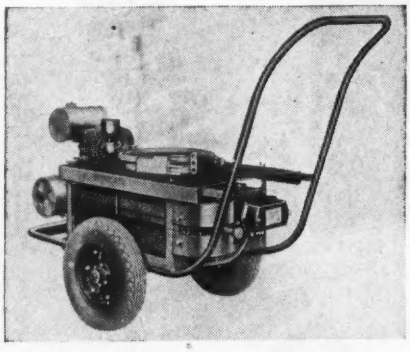
Shop Equipment and Accessories

Aircraft Relay..... 68

Exceptional resistance to shocks of flying is reported for small light aircraft relay manufactured by **Struthers-Dunn**, Philadelphia. This type, 17AXX, stated to have withstood exceedingly high acceleration tests is supplied with series coils for any direct current or with shunt coils for 12 and 24 v. d.c.—"AVIATION," Mar., '44.

Field Power Unit..... 69

On rubber-tired truck chassis of new field power unit are 4 hp. gasoline engine driving 50-amp., 30-v. shunt-wound generator for starting aircraft engines,



checking equipment for radio and gun turrets, and connections for recharging batteries. Unit is manufactured by Harman Rotary Pump Co. and distributed by Pacific Airmotive Div., **Airplane Mfg. & Supply Corp.**, Glendale, Calif., Full capacity is 480 amp. and 1,500 w.—"AVIATION," Mar., '44.

Aircraft Sound Deadener..... 70

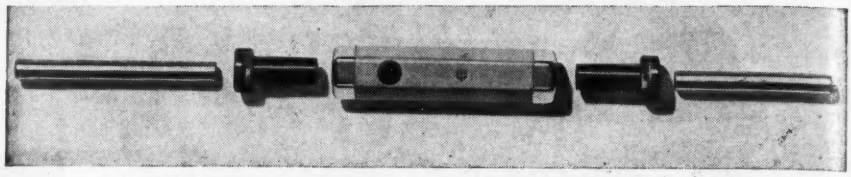
Vibeston is name given by **U. S. Rubber Co.**, New York City, to new sound and vibration deadening material composed of asbestos and other non-strategic materials. Because it is lighter than mica, previously employed for this purpose but now unavailable, new material can be used much more extensively in planes than before, thus alleviating risk of deafness faced by many combat flyers.—"AVIATION," Mar., '44.

Aircraft Heater..... 71

Spiraling flame, as shown in accompanying artist's conception (below) reignites itself even under increased air pressures is credited by **Surface Combustion**, Cleveland, with keeping new aircraft heater lighted above 35,000 ft. and during power dives. Models, which can be lighted at —70 deg. F., are manufactured in four sizes delivering from 15,000 to 125,000 Btu. per hour. Air can be supplied by auxiliary blower, in addition to usual air scoop, when ground operation is desired.—"AVIATION," Mar., '44.

Plug Gage 72

Plastic collet, slotted and tapered to fit standard gage holder, is feature of plug gage announced by **Turner Gauge Grind-**



ing Co., Ferndale, Mich. Gage can be locked in holder with finger pressure. Partial turn of end wrench will loosen it for reversing or setting at desired length. Portions of go and no go sections worn below allowed tolerances can be cut off. Eight fresh sections can thus be cut for measuring borings of ⅛ in. or less. Plastic collets, which do not mar lapped or polished surfaces, have been found as effective in grasping chrome plated and carboloy plugs as those made of regular steel. Standard plug sizes available range from .050 to .690 in. and down to .029 when required. In standard range, length of go gage runs from 1⅞ to 3½ in. and that of no go from 1⅜ to 2¼ in.—"AVIATION." Mar., '44.

Weld Recorder 73

Being used in fabrication of stainless steel aircraft parts, weld recorder registers on paper chart excessive current to welding machine. Before such surges might cause weak spot welds, recorder sounds warning bell and automatically shuts welder down. Recorder has been designed by **General Electric Co.**, Schenectady, N. Y., for use with synchronous thyratron spot welding control.—"AVIATION," Mar., '44.

Plastic Glass "Unpacker".....74

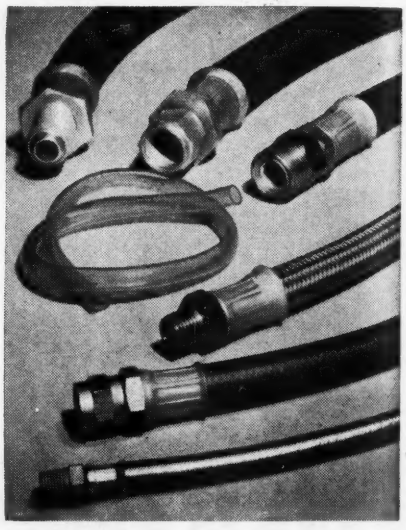
Removal of shipping papers from transparent plastic glasses, including Plexiglas, Lucite, Plastacele, acetate, and Pyralin, is stated to be simplified by new "Plasti-Clean" chemical compound developed by **Turco Products**, Los Angeles. Paper, which is likely to become vulcanized to plastic if exposed to sunlight or heat, can be peeled off after immersion in a tank of the chemical.—"AVIATION," Mar., '44.

Adjustable Relay 75

Nine-ounce relay measuring 1 3/16x 2⅜x2⅞ has adjustable core for regulating closing valve from .200 to .750 amp. Contacts are available up to three-pole, double-throw combination and are rated at 5 amp. at 115 v. 60 cycles. Coil, which can be wound for operation within wattage range of minimum .32 and maximum 4.5 has resistance of 8 ohms, according to maker, **Guardian Electric**, Chicago. Vibration resistance, energized or de-energized, is given as 8 G. Tests have been made at 45 cycles per second with excursion of .080 in.—"AVIATION," Mar., '44.

Resistant Hoses 76

Various styles of hose illustrated have core of vinyl plastic reported resistant to liquids containing high concentration of aromatics such as are found in fuel, oil,



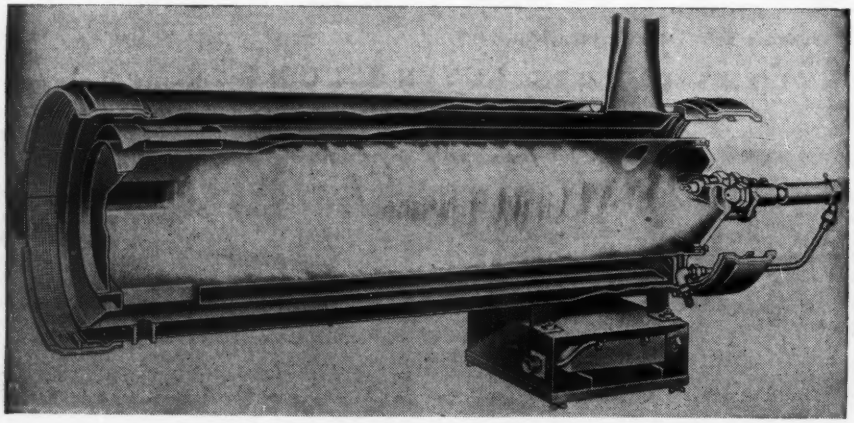
instrument, and hydraulic lines. Core, announces **Resistoflex Corp.**, Belleville, N. J., does not swell, break down, or slough from contact with aromatics.—"AVIATION," Mar., '44.

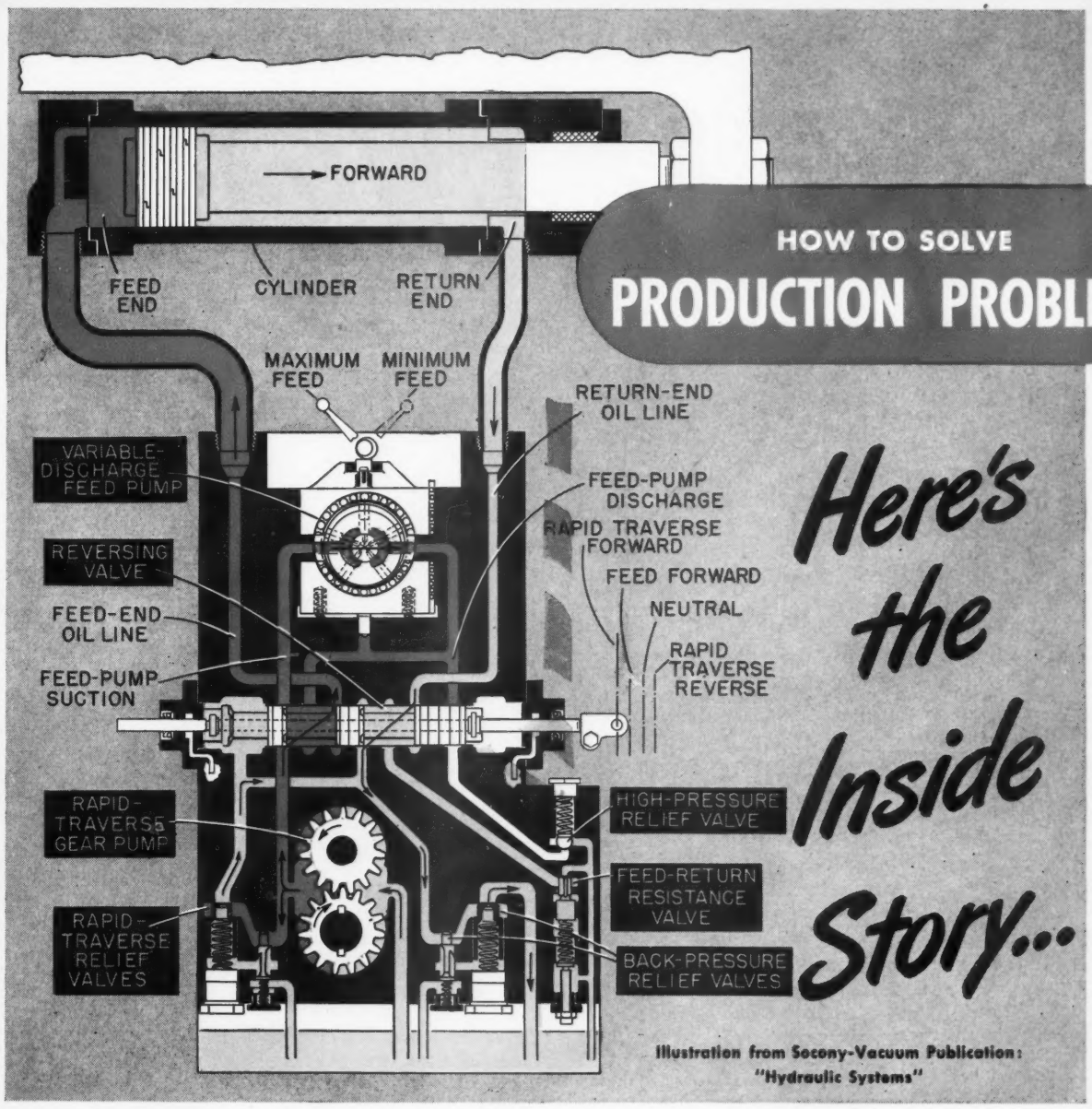
Shipping Wrapper 77

Translucent skin-like protective film has been developed for use in covering delicately finished parts while in transit. It has an ethylcellulose base, says **Dow Chemical Co.**, Midland, Mich., and "is a plastic-like substance which is applied by a simple hot dip process. It sets into a tough, skin-tight coat in a few seconds and fully protects metal from rust, corrosion, and dirt during shipment." Assembly crews, it is stated, may readily strip it off with an ordinary pocket knife.—"AVIATION," Mar., '44.

Hydraulic Fuse 78

Announced by **Alco Valve Co.**, St. Louis, is new automatic hydraulic shut-off valve for installation as unit for each four-way valve or as single unit for entire hydraulic system. In latter application, when break in system occurs, pilot isolates rupture by setting four-way valve in neutral position and then resetting fuse. When applied to four-way valve, fuse is automatic. Its mechanism consists of spring-returned displacement piston, balanced pressure and return poppets, by-pass valve, and reset lever and cam. Valve weighs 1.8 lb. Its measurements are given as 5¾x2⅝ in.—"AVIATION," Mar., '44.





HOW TO SOLVE

PRODUCTION PROBLEMS

Here's the Inside Story...

Illustration from Socony-Vacuum Publication: "Hydraulic Systems"

Why some machines produce a greater volume of acceptable work than others:

THIS IS A DIAGRAM of the hydraulic system of a modern machine tool.

Just look at all those valves, orifices, small oilways and multiple moving parts. And remember, oil must flow freely through all of them, often under widely varying conditions of temperature and pressure.

The oil you use can make a big difference in the amount and quality of your production.

Gargoyle Vacuoline Oils are ideal fluids for systems like this. Their high chemical stability resists oxidation and reduces deposits to a minimum..deposits that might gum up the valves and passageways. Their strong films resist wear and their comparatively little change in body under changing temperatures shortens starting-up periods.

Use Vacuoline Oils in hydraulic systems.

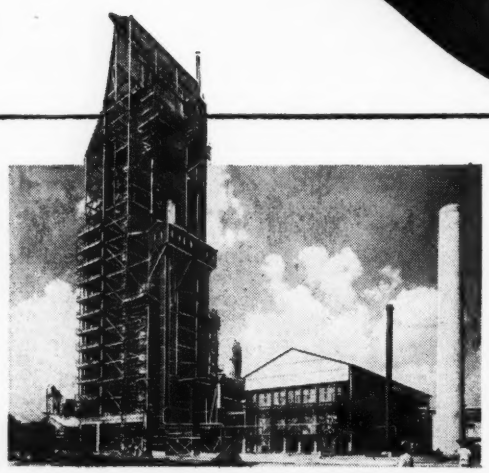
GARGOYLE Lubricants

CALL IN SOCONY-VACUUM FOR "CORRECT LUBRICATION"!

TURN PAGE

FLYING HO

PROVED IN



THE FIRST HOME OF
FLYING HORSEPOWER!

This new TCC Refinery at Beaumont, Texas, is "on stream" now, producing a flood of the world's finest base stock for Aero Mobilgas. First home of Flying Horsepower, the new plant climaxes ten years of petroleum research. With it, aviation's dream of a super fuel in volume comes true.

Get the Facts on the NEW **Aero**

RSEPOWER

D IN WAR · · · READY FOR PEACE!

Aero Mobilgas now flowing from Socony-Vacuum's Great TCC Refinery Units!

Now America's super war and cargo planes are getting super power—Flying Horsepower—in volume for Victory.

Socony-Vacuum's revolutionary Thermofor Catalytic Cracking plant at Beaumont, Texas—first of 31 new TCC plants in the U.S.—is in full production. It's turning out a steady stream of the base stock that provides this super power for new Aero Mobilgas.

Result of two great petroleum advances—the TCC process and a new bead catalyst—Flying Horsepower adds hundreds of miles range to bombers, gives fighters greater maneuverability.

It's by far the greatest gasoline development of this war, a practical reality for peacetime application.

New Aero Mobiloil from the World's Greatest Lubrication Experience!

Used in the aircraft industry for crucial engine break-ins—a new Aero Mobiloil to match the new Aero Mobilgas.

Latest development from Socony-Vacuum's 78 years' lubrication experience, the new oil has already proved its exceptional wear-resisting qualities.

In gruelling flight operations, it has kept engines free from ring-clogging deposits, and reduced ring wear to a minimum.

New Aero Mobilgas and new Aero Mobiloil combine to furnish and protect Flying Horsepower for the planes of Today—and Tomorrow.

SOCONY-VACUUM OIL CO., INC. and Affiliates: Magnolia Petroleum Co., General Petroleum Corp. of California.

Mobilgas-Mobiloil

FACTS ABOUT AEROVAC E. P. GEAR OILS

Low Temperature, Extreme Pressure Gear Oil Gives Correct Lubrication at -55 Degrees F.

IN THE EXTREME COLD of the stratosphere and under the terrific pressures of opening bomb bay doors, Socony-Vacuum Aerovac E. P. Gear Oils have proved their efficiency over and over again. For, like all other Socony-Vacuum aviation products, they're designed for the job. They protect gears under heavy loads—provide Correct Lubrication at temperatures down to -55° F. Be sure to get the facts about these oils.

AEROVAC E. P. GEAR OILS NOW USED IN:

- ✓ **Landing Mechanism Motors**
- ✓ **Wing Flap Motors**
- ✓ **Bomb Bay Door Motors**
- ✓ **Gun Turret Motors**
- ✓ **Engine Reduction Gears**

SOCONY-VACUUM OFFERS A COMPLETE LINE OF:

Aviation Greases

Specially designed greases for high temperatures, low temperatures, and extreme pressure conditions.

Aviation "Specialty" Oils

Special oils and fluids for instruments, low-temperature oils, hydraulic oils, general lubricating oils.

SOCONY-VACUUM OIL CO., INC.

and Affiliates: Magnolia Petroleum Company, General Petroleum Corporation of California

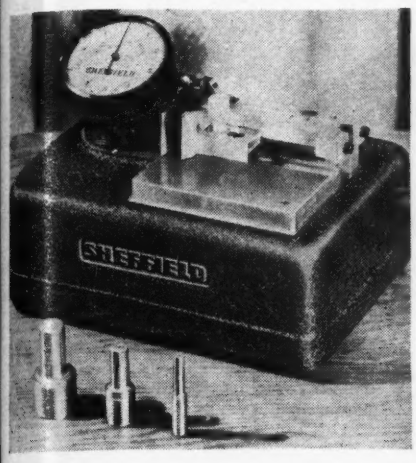
AVIATION DIVISION
26 Broadway
New York, N. Y.

GARGOYLE Lubricants

Socony-Vacuum is backed by 78 years of Lubrication Experience!

Thread Checker 79

Capacities of machine for checking threads on studs and small shafts are accuracy .0001 in., length 2 in., thread size 40 pitch to 2¼ threads per inch, and



diameters of .125 to 2 in. Dial indicator, announces maker, **Sheffield Corp.**, Dayton, Ohio, has range of .010 in. graduated in increments of .0001.—"AVIATION, Mar., '44.

Steel-Welding Electrode 80

"Fleetweld 37" is name given by **Lincoln Electric Co.**, Cleveland, to new electrode for alternating and direct current welding of mild and low alloy steels. Company reports no slag interference when welding down vertically and says that electrode will take higher currents and thus increases welding speeds. Light gage welding is also facilitated by fact that electrode does not stick to work nor burn through. It is supplied in 50-lb. containers in 14-in. lengths of 1/8-, 5/32-, and 3/16-in. dia. Physical properties of weld specimens are given as tensile strength 70,000 to 80,000 psi. and yield strength 60,000 to 68,000 psi.—"AVIATION," Mar., '44.

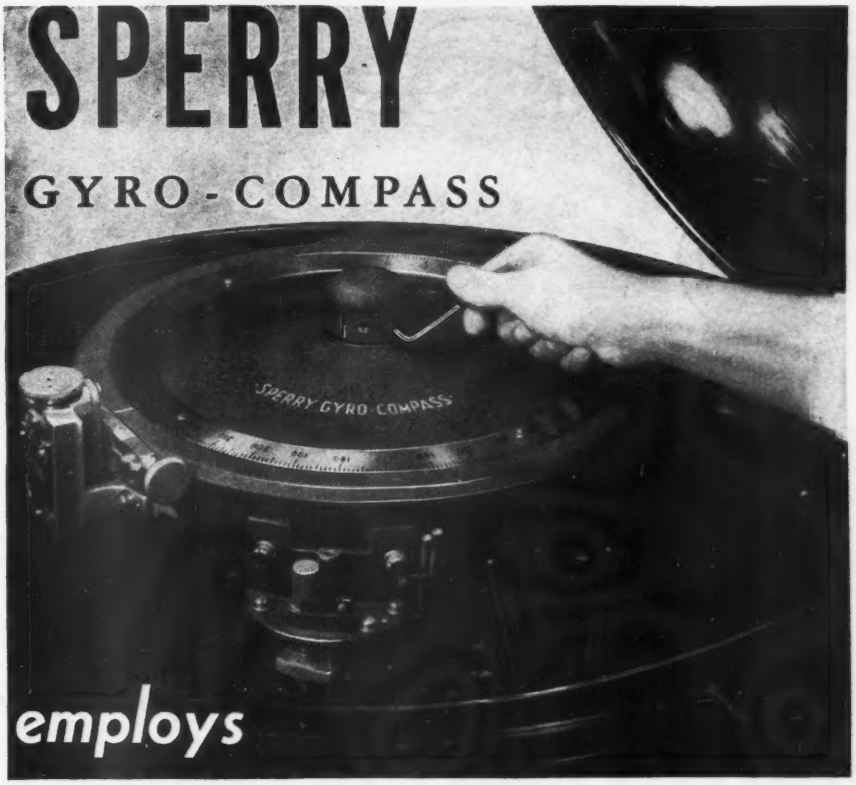
Circuit Breaker 81

Disk producing make-and-break contacts unaffected by motion is chief element in remote control circuit breaker which can be reset from operating panel. Produced in three frame sizes and capacities of 35 to 200 amp. on 30 v. d.c. and 220 v. a.c., breaker is available in trip-

free and non-trip-free styles. Action in latter can be over-ridden from control panel by pilot. Device trips at 125 percent of rating in ambient of 77 deg. F. but will carry 115 percent of rating continuously. It is a product of **Spencer Thermostat** Co., Attleboro, Mass. —"AVIATION," Mar., '44.

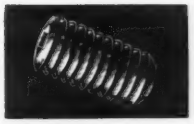
SPERRY

GYRO-COMPASS



employs

ALLEN



HOLLOW SET SCREW

in suspension head

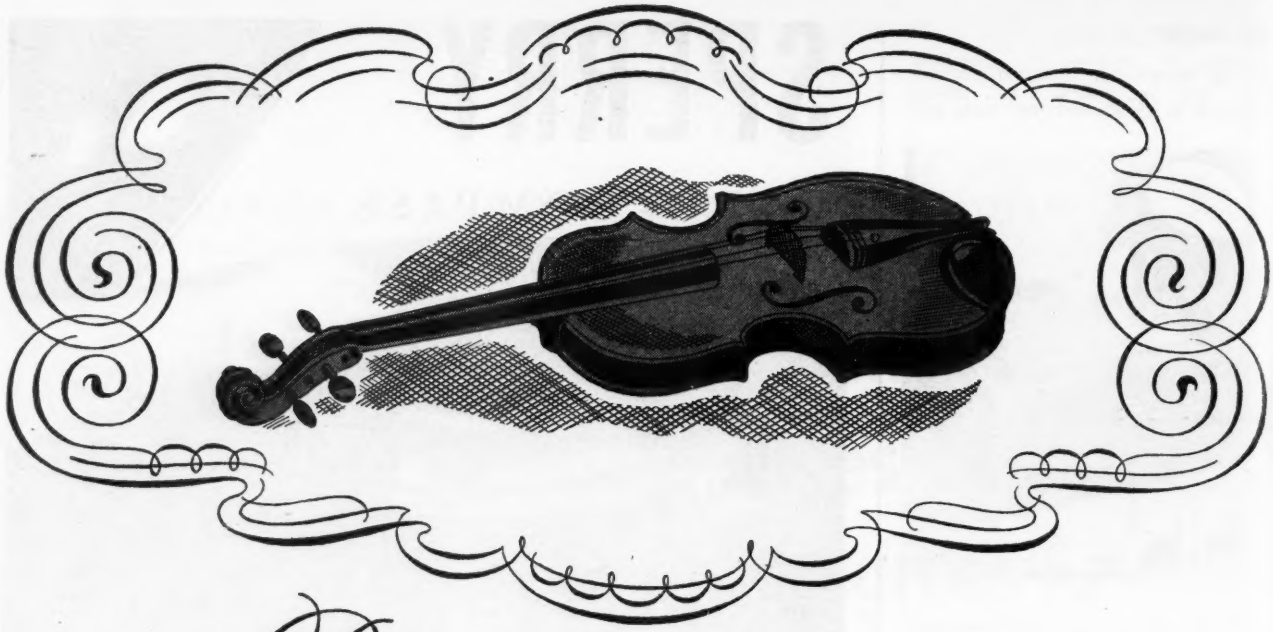
SPERRY Gyro-Compass derives its directive force basically from the earth's rotation and pull of gravity, not its magnetic field. This directive force, the true north determinant, is 150 times greater than that which actuates the magnetic compass. Immune to local magnetic attractions, it is free from variation and deviation, and unaffected by motion of a vessel. It enables the helmsman to steer a true course with less rudder, with less power expenditure, and greatly simplifies the problems of the navigator.

Manifestly this instrument, unerringly responsive to natural laws, embodies a superlative degree of mechanical precision in its parts, in its assembly and its adjustments. In its suspension head, as shown in the photo reproduced, an ALLEN Set Screw ensures the accuracy and fixity of a critical adjustment.

Allen Hollow Screws distributed only through local Industrial Distributors in all centers.

THE ALLEN MANUFACTURING COMPANY

HARTFORD, ★ ALLEN ★ CONNECTICUT, U.S.A.



Proved true by time

Time alone can prove how good capacitors are. The enviable reputation of Tobe Capacitors for *long life* rests on an almost complete absence of "returns". Such things don't "just happen". Back of Tobe Capacitors are constant research, specialized manufacturing experience and rigid inspections. Ratings are always on the conservative side.

Whatever your condenser problems, we invite you to put them up to our engineers. You will receive prompt service and close co-operation.

LONG LIFE ASSURED

TOBE DEUTSCHMANN CORP. CANTON · MASSACHUSETTS

TOBE

TRS 605,
5 mfd. 600 volts
SIZE—
Overall height 5"
CONTAINER—
1 3/16" x 2 1/2" x 4"
Dimensions of other TRS models on request.

SPECIFICATIONS FOR TRS CAPACITORS

CAPACITY—.1 to 50.0 mfd.

WORKING VOLTAGE—600 volts DC to 6,000 volts DC.

SHUNT RESISTANCE—15,000 megohms per mfd.

RESISTANCE Terminal to Case—10,000 megohms minimum.

POWER FACTOR—.002 to .005

VOLTAGE TEST Terminal to Case—2,500 VDC for 600 volt condensers.

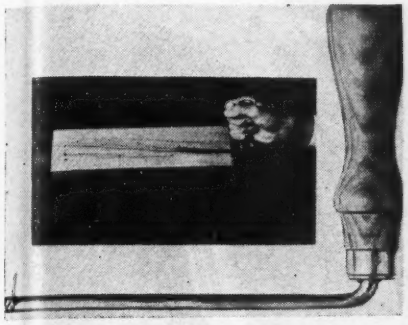
Capacitor unit tested at 2½ times rated voltage.

Universal (wrap around) L or foot type and screw Spade-lug mounting brackets can be supplied.

***A small part in Victory today . . .* A BIG PART IN INDUSTRY TOMORROW**

Lumber Grain Detector..... 80

To aid in classifying aircraft lumber, tool for indicating direction of its grain has been developed by **Timber Engineering Co.**, Washington, D. C. Load values of lumber are fixed according to slope of



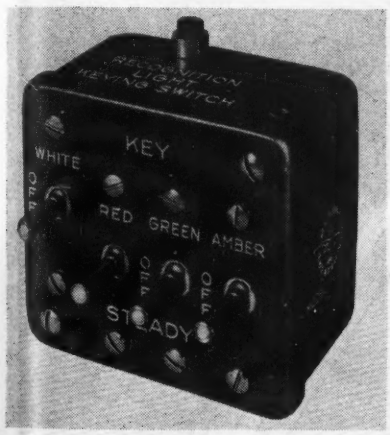
grain from a line parallel to sides of piece. Needle on end of device follows grain, thus allowing angle of deviation to be calculated as shown in inset portion of photo.—"AVIATION" Mar., '44.

Piston Cleaner 83

Process for cleaning aviation pistons is described by **The Curran Corp.**, Malden, Mass., as a combination of chemical solvents "supplemented by a mechanical hydraulic blast to which is added a cereal or plastic abrasive." Cleaning time on pistons after 1,000 hr. of service is reported to be considerably reduced.—"AVIATION," Mar., '44.

Recognition Switch 84

Possible total of 81 different combinations of outside aircraft lights for recognition and identification are available with new switch which can set white, red, green, and amber lights in steady, off, and keying positions. Box and cover of this model, LS-15, from Pacific Div., **Bendix Aviation Corps**, North Hollywood, Calif., are made of drawn aluminum alloy painted to user's specification's. Toggle switches are luminous,



and keying switch can take load of 140 w. Holes for the five wires necessary may be drilled any place in box, which may be mounted wherever convenient. Its over-all dimensions are 3 3/16x3 7/16 x2 7/8 and weight 11.5 oz.—"AVIATION," Mar., '44.

Whiteprint Dry Developer 85

Two reproduction speeds—4 and 8 ft. per min.—are provided on table model machine for dry developing whiteprint copies of engineering drawings and tracings. It can be used, says **C. F. Pease Co.**, Chicago, in conjunction with any blueprinting or direct process printing machine employing dry paper. Machine is welded steel, has removable sheet metal guards, also forward and reversing controls.—"AVIATION," Mar., '44.

All of the TITE SEAL needed to service a modern plane costs only a few dollars, but the service it renders is priceless.

In aviation's early days oil, gasoline and power leaks were major hazards. The discovery of TITE SEAL, in the early twenties, eliminated these hazards and thereby contributed mightily to flying safety.

TITE SEAL gasketing and sealing compounds were developed by the aviation industry itself, to meet flying conditions. TITE SEAL is *indestructible*. It is unaffected by temperature extremes or by any fluids or gases encountered in motors or instruments. TITE SEAL is non-hardening vibration-proof and pressure-tite.

There is a density of TITE SEAL for every gasketing and sealing need. For Safety's Sake, always specify TITE SEAL.

FOR DETAILED INFORMATION ABOUT **TiteSeal** WRITE

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Veteran in Search of a Peacetime Future

THIS veteran knows of no job to come back to after the war.

It was born of war necessity — built to perform a strategic purpose new in the history of aircraft.

The requirements were an engineering challenge. It had to be strong to do its heavy work. Yet it had to be light and fit in the small space available.

That is why even optimists doubted such a device could be built.

But here it is: The Lear Actuator.

Its job is operating flaps, landing gears, shutters and other equipment on the power of an airplane storage battery.

Now, of course, our plants are working round the clock to make enough of these for the fighting ships of Uncle Sam.

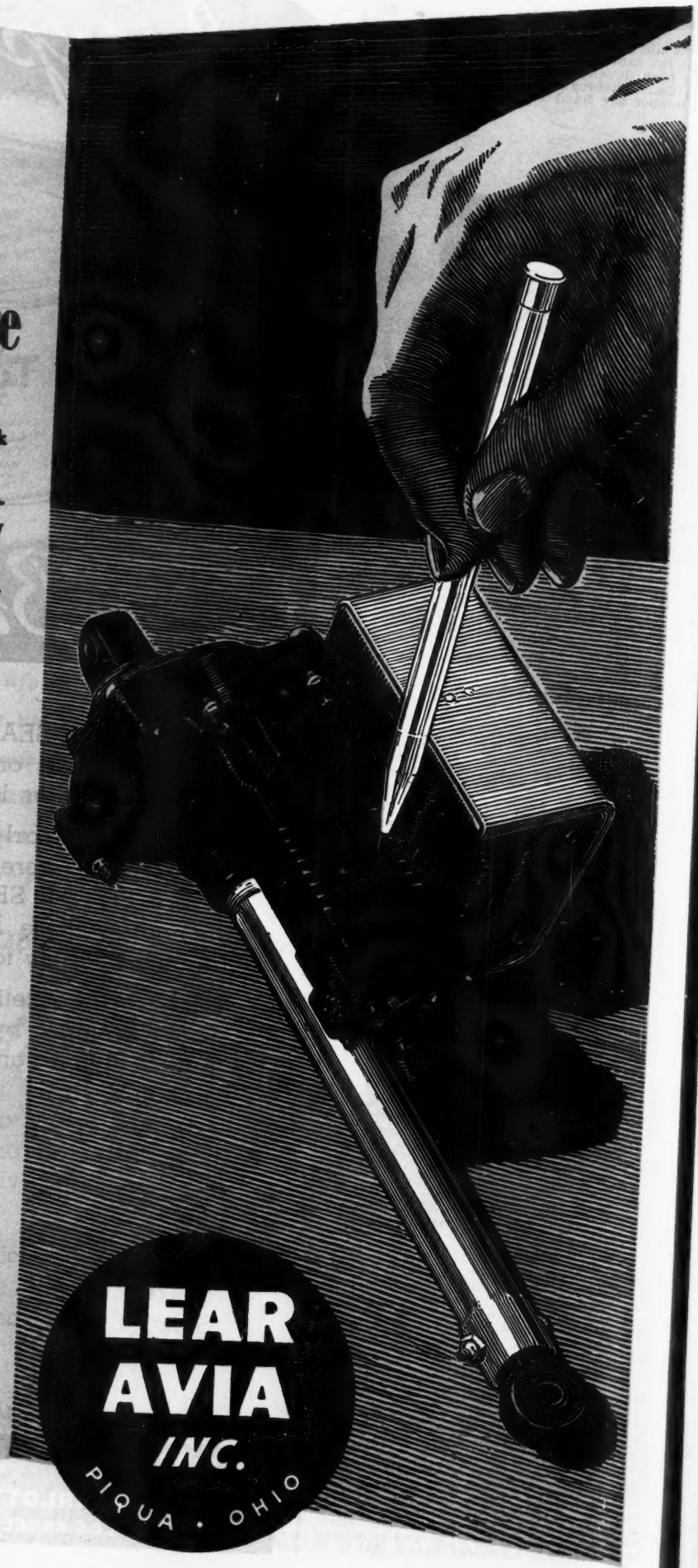
But we know that such unique devices, the midget motors that drive them and all the 250 Lear products, must have an important future in some peacetime products.

They may park your car with the push of a button — or do any of thousands of jobs we haven't thought of.

That is why we are telling you about them. We want to find jobs for these able veterans.

And we want you to know that the kind of engineering thinking and production technique that made them possible is available.

PLANTS: Piqua, O., and Grand Rapids, Mich. BRANCHES AT: New York, Los Angeles, Chicago, Detroit, Cleveland, Providence.



LEAR AVIA INC.
PIQUA · OHIO

ASSEMBLE THEM FASTER . . . AND CHEAPER

Stitch 'em with Wire!

Wire stitching to speed up the assembly of airplane and glider parts has advantages over both riveting and welding. It increases production. It lowers cost. It does not require skilled labor.

U·S·S American Aircraft Stitching Wire is tough and ductile enough to form sharp, tight corner bends so that it clinches flat on the underside to provide full bearing on the material. Yet it is so hard that it actually punches a clean slug out of the base metal about the size of the wire itself. Thus it produces a clean hole—with no tearing puncture in the base material nor burring of the hole. No cracking of the material occurs with attendant notch effect that localizes stresses under various load factors.

U·S·S American Aircraft Stitching Wire will penetrate gauges up to .035″ for half hard stainless steel—up to .060″ for SO aluminum and up to .040″ for 24ST aluminum. It is heavily coated with a tightly adhering zinc coating to withstand a minimum of 300 hours salt spray test.

Proved under the toughest operating conditions, this high carbon steel wire is .051″ size (with all tolerances under) and has a minimum tensile strength of 290,000 lbs. per square inch. It is put up on 5 and 10 lb. cores ready for mounting on stapling machines. (A 5-lb. core of American Aircraft Stitching Wire makes approximately 10,000 stitches.) We welcome the opportunity of discussing the application of this product to your wire-stitching needs.

ADVANTAGES

Strongly joins metal to metal, or metal to rubber, wood, asbestos, fabric, leather and plastics - without backing strip.

Requires less highly skilled workmen.

Stitches can be applied about 10 times as fast as rivets — about twice as fast as welding spots.

Faying surfaces may be painted before fastening.

Work need not be cleaned before fastening.

Mating and clamping of work is less critical.

Inspection time and skill required are reduced.

Flange distance can be reduced.

Power requirements and initial cost of stitching equipment are considerably lower than for any type of welding.

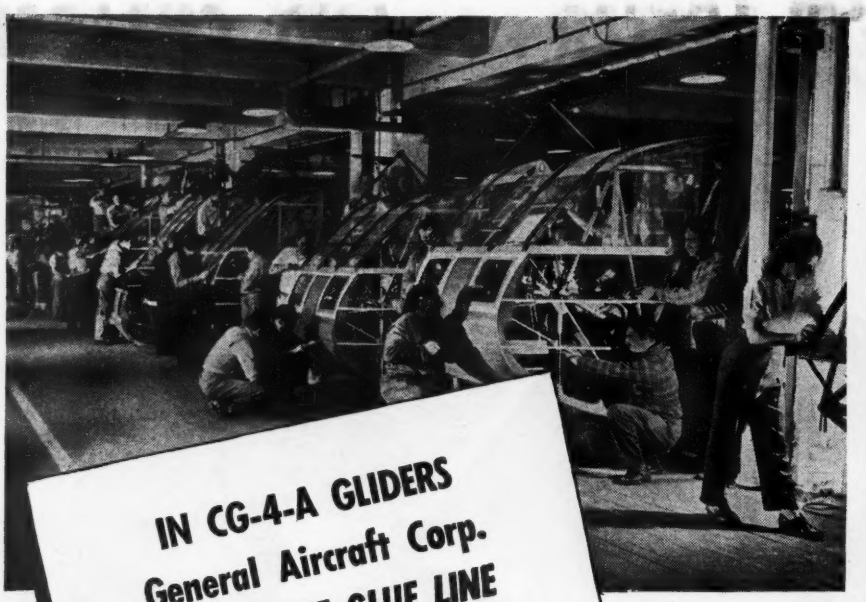
AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago, and New York

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

U·S·S AMERICAN AIRCRAFT STITCHING WIRE

UNITED STATES STEEL



IN CG-4-A GLIDERS General Aircraft Corp. MAKES THE GLUE LINE THE SAFETY LINE

Where men's lives depend on the holding power of a glue, there you'll find Weldwood!

General Aircraft Corporation makes extensive use of this plastic resin adhesive in its CG-4-A Gliders!

Used and accepted by the Army, Navy and C.A.A., Weldwood Glue is shear-proof, water-proof, rot-proof and bacteria-proof!

A fine powder, Weldwood Glue mixes instantly with ordinary tap water and is ready for immediate use without heating or waiting.

It sets cold—and *permanently!*

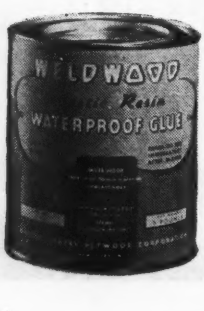
Jobs can be handled in a few hours after clamping.

Available in 10 lb. and 25 lb. cans as well as in 100 lb. and 300 lb. drums from your mill supply dealer, industrial distributor or from one of our warehouses conveniently located from coast to coast.

Use the coupon for a FREE sample and full information on this aviation industry adhesive.

WELDWOOD
PLASTIC RESIN
WATERPROOF GLUE

Weldwood



UNITED STATES PLYWOOD CORPORATION
Weldwood Glue Dept. 51, 55 West 44th St., New York 18, N. Y.

Please send literature, sample and prices on Weldwood Glue.

*Name*_____

*Company*_____

*Address*_____

*Our Regular Dealer is*_____

"Self-Starting" Tire 86

Vanes built into sidewall of new plane tire start it spinning when landing gear is lowered and reduce friction of impact

against ground. Vanes, reports maker, **B. F. Goodrich Co.,** Akron, are made of rubber and fabric and are so constructed and placed that they spring back into position flush with tire's side on "upper half" of each rotation of wheel. Landings are said to be smoother and tire life greatly increased.—**"AVIATION,"** Mar., '44.

Sine Plate 87

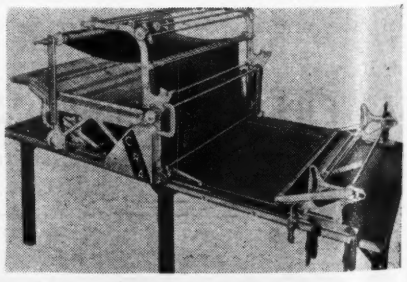
Small tools and parts measuring up to 6x10 in. can be checked on new sine plate marketed by **Carruth Sales Co.,** Detroit. Building up of gage blocks produces desired measuring angle between stationary locating plate and cylindrical gage bar on movable block. Latter has 54⅝ in. holes for clamping work being inspected. Guide plate is provided on one end of movable block, and another plate can be attached to either side as subject material requires.—**"AVIATION,"** Mar., '44.

Belt Sander 88

Contoured metal, fiber, wood, or plastic parts up to 36x60 in. and any length up to 12-in. wide can be accommodated on rolling work table of belt sander announced by **Boice-Crane Co.,** Toledo. Control is provided for either light spot touch-ups or for heavy over-all cuts. Drive belt tension is maintained by an automatic device; belt is 6 in. wide. Multiple fixtures can be attached to table to handle numbers of small parts simultaneously.—**"AVIATION,"** Mar., '44.

Chute-Cloth Spreader 89

Elimination of pockets or wrinkles in cloth which might distort shape of finished parachutes has been achieved, announces **Cutting Room Appliances Corp.,** New York City, by use of an automatic



cloth spreader. Requiring only one unskilled operator, machine also is stated to increase production.—**"AVIATION,"** Mar., '44.

Lace for a Lady

Those ammunition links represent plenty of American ingenuity and production skill . . .

In the jungle heat, your armorer loaded the deadly "lace" aboard your P-38. Now, escorting bombers you're headed for Rabaul.

Then—out of nowhere—Zeros!

You pick yours—as you press the firing button, the yellow ribbon of linked cartridges feeds into your nose guns. There's never a hitch as you pour it on at the rate of 900 shells a minute.

Yes, from cartridge links to bombers, our fighters are getting the finest!

If a fighter's guns jam, he's really in trouble. To minimize this possibility engineers of the Spring Division of Borg-Warner have been hard at work on machine gun and cannon link problems since Pearl Harbor. In co-operation with Army engineers they have developed four new links and had an active part in the Army's program which now produces a .50 calibre link of vastly improved performance. The Spring Division of Borg-Warner produces various size links by the million.

To the making of these precision links and over 100 other war items, we apply the idea that is basic with Borg-Warner: "design it better—make it better."

Your industry has felt the benefits of this idea through every Borg-Warner product ever supplied to you. Upon this well-proved confidence we hope to build an even closer association in the days ahead.

Partners with the Aviation industry in peace and war, Borg-Warner supplies these and other essential parts . . .

HYDRAULIC, VACUUM AND FUEL PUMPS
REDUCTION AND PROPELLOR GEARS
UNIVERSAL JOINTS · CARBURETORS · ENGINE PARTS
AIRCRAFT CONTROL CHAINS · AIRCRAFT CLUTCHES
POWER TURRETS · OIL COOLERS
HELICOPTER TRANSMISSIONS
COIL SPRINGS AND FLAT SPRINGS

ENGINEERING B-W PRODUCTION

BORG-WARNER

Peacetime makers of essential operating parts for the automotive, aviation, marine and farm implement industries, and of Norge home appliances . . . *these units which form the Borg-Warner Corporation are today devoted exclusively to the needs of war:* BORG & BECK • BORG-WARNER INTERNATIONAL • BORG-WARNER SERVICE PARTS • CALUMET STEEL • DETROIT GEAR AIRCRAFT PARTS • INGERSOLL STEEL & DISC • LONG • MARBON • MARVEL-SCHEBLER CARBURETER • MCCULLOCH ENGINEERING • MECHANICS UNIVERSAL JOINT • MORSE CHAIN • NORGE • NORGE MACHINE PRODUCTS • PESCO • ROCKFORD CLUTCH • SPRING DIVISION • WARNER AUTOMOTIVE PARTS • WARNER GEAR

Setting the Pace!

North American, with its new 75-mm. cannon-carrying B-25 Mitchell bomber, sets the pace in the field of aircraft armament. This Mitchell bomber, plus the Mustang fighter and Texan combat trainer . . . all products of North American Aviation, Inc. . . . are equipped with Wittek Aviation Hose Clamps. The dependability of Wittek Hose Clamps, long accepted by the aviation and automotive industries, is now being proven in actual service with the armed forces of the United Nations. Wittek Manufacturing Co., Chicago 23, Ill.

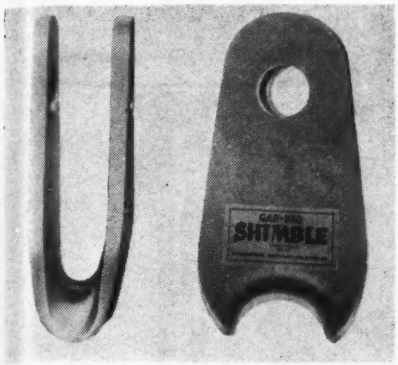
ARMY E NAVY

War Bonds for Victory—
Buy MORE in '44!

WITTEK *Aviation* **HOSE CLAMPS**

Shackle-Thimble 90

Combination shackle and thimble for control cables is being made in aircraft styles for rope from 1/8 to 1 5/8 in. by **Garlinghouse Bros.**, Los Angeles. Two



available styles, standard shackle and regular socket equivalents, are manufactured from hot forged mild steel bars for supporting rope in non-collapsible contours. Illustration shows front and side views.—"AVIATION," Mar., '44.

Parts Balancer 91

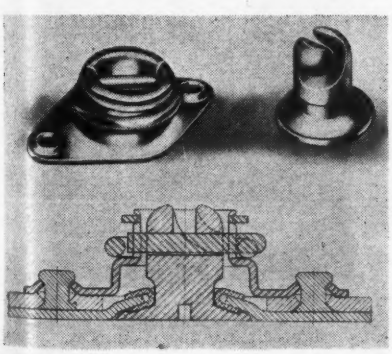
With new portable equipment, dynamic balancing of machine parts either in their own bearings or in bearings made for the purpose can now be accomplished, it is reported, by single person. This elimination of second operator to make adjustments has been made possible by incorporation of remote control switch on panel of vibrometer, according to maker, **Vibroscope**, Inc., New York City. Apparatus, in addition to new switch feature and vibrometer to measure directly vibration amplitude, consists of stroboscope to give visual reading of phase angle and portable carrying case which also contains batteries. Available are 22-lb. and 25-lb. models.—"AVIATION," Mar., '44.

All-Weather Welder 92

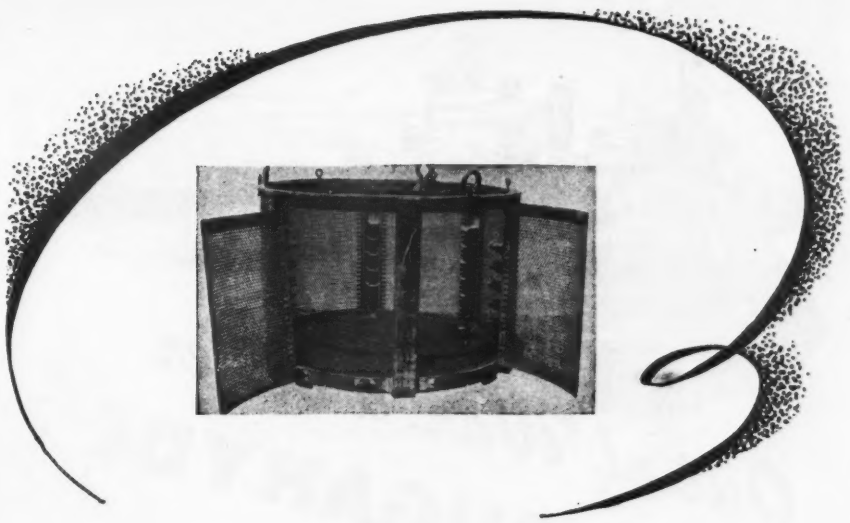
Protected by moisture-proof insulation and paint and by weather-resisting enamel case with rain-stopping gaskets, welder for outdoor use is manufactured in 300 and 500 amp. capacities by Wilson Welder and Metals Co. It is distributed by **Air Reduction Sales Co.**, New York City. Machine is also equipped with automatic low voltage contactor which holds open circuit current at approximately 40 v. When arc is struck, contactor closes and transformer operates as usual; when arc is extinguished, voltage is cut back to 40 again.—"AVIATION," Mar., '44.

Cowling Fastener.....93

Rights to manufacture spring-lock fastener invented by Dr. E. L. Mack and perfected by Aircraft Parts Development Corp., have been acquired by **Elastic Stop Nut Corp.**, Union, N. J. Suitable for holding engine cowlings in place, fastener is reported approved by Army and Navy.



Top panel of photo shows receptacle (left) and stud (right); lower panel outlines cross-section of assembly in locked position.—"AVIATION," Mar., '44.



KEEPING UP

Speed and reliance, the keynotes and watchwords of the aircraft industry, are more quickly achieved by installing equipment such as Pressed Steel Carburizing, Annealing and chemically resistant products. These Pressed Steel products represent every advancement and advantage known to man and help to create production efficiency, economy and durability. For example, "P. S." products weigh 70% less than the ordinary, while they retain all, sometimes more, of the strength, accuracy and flexibility of the heavier, clumsier types. This lighter weight renders "P. S." products more adaptable to installation requirements while it provides the utmost savings in operating time and replacement. Add a "P. S." for Pressed Steel, to every order or specification for Carburizing, Annealing and chemically resistant equipment.

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

BRANCH OFFICES: 312 Curtis Bldg., Detroit; 1914 Vermont Ave., Toledo; 1915 Engineers Bldg., Chicago; 254 W. 31st St., New York; 415 Petroleum Bldg., Houston, Texas; A & M Accessories Ltd., 19 Melinda St., Toronto, Canada

PRESSED STEEL COMPANY PRODUCTS: Carburizing and Annealing Boxes, Thermocouple Protection Tubes, Seamless Steel Cylinder Caps, Seamless Steel Neck Rings, Welded Alloy Tubing for High Temperature and Corrosive Application, Radient Tubes, Inner Covers and Base Sheathes for Steel Mills

Out of War, a better

NAUGAHYDE

Now, as in peacetime, we are specializing in the development and production of fabrics for specific needs. In war, Naugahyde has scores of vital jobs, meets numerous government specifications . . . from flameproof berth covers for Navy fighting ships to seat upholstery for trucks, tanks, and airplanes.

Prior to Pearl Harbor we had already started developments to improve our commercial products through the use of plastics. This work was of tremendous value when we were called upon to furnish an almost unlimited number of special coated fabrics, for the Armed Forces.

War developments have also increased our abilities in the techniques of coating not only cotton but rayon, nylon, glass and other fabrics, using plastics or synthetic rubber coatings each designed for a specific purpose.

As we work to win the war, many new developments are coming from our laboratories which will result in a greatly improved family of Naugahyde Upholstery Fabrics after the war. Then, you will find that no matter what your upholstery problem—no matter how specialized it is—there is a Naugahyde Upholstery Fabric for you that resists wear, looks smart, costs little.

NAUGAHYDE

NAUGAHYDE is now manufactured and sold to conform with the following specifications: 34L13 Bureau of Ships; E-KK-L-136a, Type 3 Federal Specification; 12026A Air Corps Fireproof Specification; 27F11 U.S. Navy; AXS-992 Ordnance Department; MN245 (both types) Maritime Commission.

Serving through Science

United States Rubber Company

1230 Sixth Avenue • Rockefeller Center • New York 20, N.Y.

Rivet Set 94

Danger of dinging thin skins is reported to be reduced by oversize rivet set (2½ in. dia.) made from heat-treated tool steel. It is finished with smooth crown surface to protect skins from dents

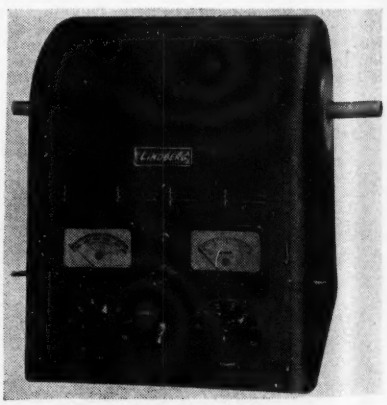
and abraslons, and even flow of grain is calculated to produce high impact resistance and minimum possibility of fractures. Manufacturer is **Aero Tool Co.**, Burbank, Calif.—**"AVIATION,"** Mar., '44.

Plywood Plane Flooring 95

Development of plywood aircraft flooring which can be furnished in any thickness is announced by **Technical Fly-Woods,** Chicago. Between top and bottom ply surfaces, which can be faced with vulcanized fiber as a wearing surface, are narrow grid strips of spruce. This combination, approximately ⅜-in. thick, is stated to weigh about .85 lb. per sq. ft. and to carry load of 800 lb. per sq. ft. on 18-in. spans; deflection of about 3/16 in. under this load is not permanent. Panels of this material are being made up to 25 ft. long and 4 ft. wide.—**"AVIATION," Mar. '44.**

Lab Furnace 96

For making carbon, sulphur, and gavimetric determinations of carbon, alloy, stainless, and heat-resistant steels, new Model CF-1 single tube combustion furnace will maintain continuous temperature of 2,500 deg. F. Globar elements can be installed or removed without dismantling. On furnace face are coarse and fine adjustment knobs for regulating temperatures through built-in variable-voltage transformer. Heat-indicating pyrometer is connected to platinum thermocouple. Oxygen is controlled by needle valve connected to rubber tubing adapters at both ends of housing. Signal light indicates when furnace is warming. Adapters allow interchanging of standard combustion tubes 1, 1¼, and 1½ in. o.d. Tube of 2 in. o.d. can be used with-



out adapter. Standard current supply should be 110 or 220 v. 60 cycle a.c. though model can be supplied for 25 cycles. **Lindberg Engineering Co.**, Chicago, gives demensions of furnace as 17½x15x21½ in.—**"AVIATION,"** Mar., '44.

Why VIP* Fly

*VIP is Army slanguage
for "very important people".

The greater their importance,
the greater the need
to measure their journeys
by *time* – not distance.

That means AIR TRAVEL.

VIP means Presidents,
Prime Ministers,
Secretaries of State,
Diplomats, Senators,
Secretaries of War, and Navy,
Generals, Admirals, Technicians.

Yes, and VIP means the wounded
flown to base hospitals,
troop reinforcements
and paratroops.

When the war has been won
you, too, will be VIP,
for you will measure your journeys
by *time* – not distance.

Then again your seat
in a Douglas transport
will be just as important
as any famous person's
going your way.

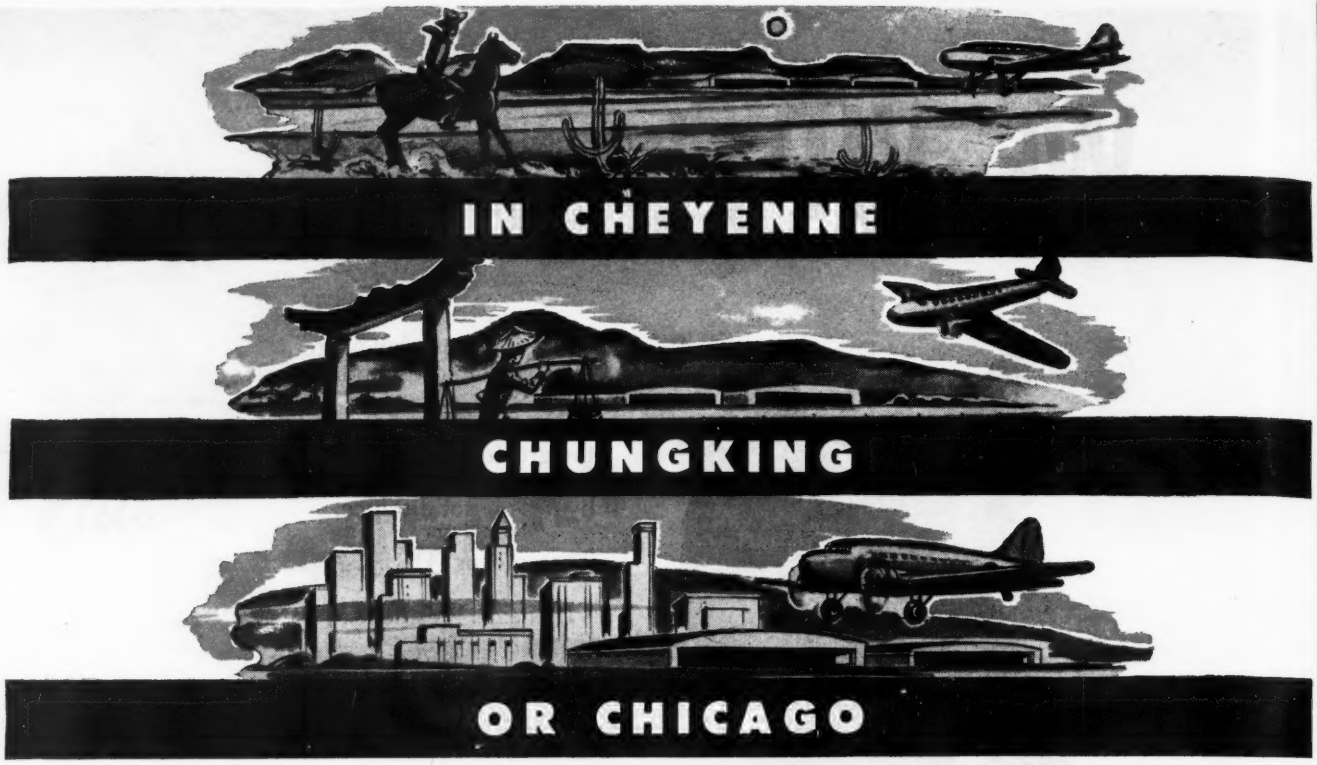
Douglas
AIRCRAFT

Santa Monica, Calif.

Long Beach El Segundo, and Daggett, Calif., Tulsa, Oklahoma, Oklahoma City, Chicago

Member, Aircraft War Production Council, Inc.

These World-Wide Airlines Are Douglas Equipped: American Airlines . . . Braniff Airways . . . Chicago & Southern Air Lines . . . Colonial Airlines . . . Delta Air Lines . . . Eastern Air Lines . . . Western Air Lines . . . Northeast Airlines . . . Northwest Airlines . . . Pan American Airways . . . Pennsylvania-Central Airlines . . . Transcontinental and Western Air . . . United Air Lines . . . China National Airways . . . Pan American-Grace Airways, Inc. . . . Avianca (Aerovias Nacionales de Colombia) . . . Cia. Mexicana de Aviacion . . . Panair Do Brazil . . . Cia. Nacional Cubana de Aviacion, S. A. . . . Uraba, Medellin and Central Airways, Inc. . . . Cruzeiro do Sul (Brazil) . . . Primeras Lineas Uruguayas de Navegacion Aerea, S. A. . . . Aerovias de Guatemala, S. A. . . . Canadian Pacific Airlines, Ltd. . . . Australian National Airlines . . . Royal Dutch Airlines (K.L.M.) . . . Royal Netherlands Indies Airways (K.N.I.L.M.) . . . Sabena (Belgian Congo) . . . Swissair (Switzerland) . . . A. B. Aerotransport (Sweden) . . . Indian National Airways (India) . . . L.A.P.E. (Spain) . . . Aer Lingus (Ireland) . . . American Airlines of Mexico . . . British Overseas Airways Corp. (BOAC) (England).



A SINGLE STANDARD OF BRAKE EFFICIENCY with this SCIENTIFIC MEASURING DEVICE

Indisputable measurement of brake efficiency is essential to safe, economical operation and maximum flying availability—

SEND FOR THIS BOOKLET

Your standard of brake efficiency can be definite—uniform—regardless of geography or language! Wherever airports or shops use this Bennett-Feragen Aircraft Brake Tester, exact and indisputable measurement replaces opinions, trials and errors.

Bennett-Feragen Aircraft Brake Tester is engineered by the leading designers and manufacturers of aircraft and automotive Safety Service equipment. It is adjustable to all tread widths up to 40 feet and applicable to all types of brakes. Write today for complete information.

SAFETY EQUIPMENT CO.

Bennett-Feragen Equipment for Safety Service

SOUTH BEND, INDIANA

Ignition Cable 97

Neoprene-sheathed cable with high heat, moisture, and oil resistance for aircraft ignition is announced by **General Electric Co.**, Bridgeport, Conn. Construction is twisted Monel wires insulated with low-capacitance rubber compound reinforced by braid of glass yarn.—"AVIATION," Mar., '44.

Vibration Absorbent 98

Studies are being made of use of new vibration absorbing process in propeller shafts and engine mountings. Method called "Silentbloc" by **General Tire & Rubber Co.**, Akron, Ohio, employs steel and rubber. Latter, forced at high speed between two pieces of metal, tries to regain its original shape, thus creates a bond to steel. Result, says company, "is that method will sustain axial, radial, conical, or torque loads, eliminates necessity for lubrication, and gives longer wear.—"AVIATION," Mar., '44.

Electrical Brushes 99

Two years' research, announces **National Carbon Co.**, New York City, have resulted "in development of a series of brush grades affording a range of operating characteristics sufficiently broad to cover practically every type of rotating electrical equipment used in aircraft and designed to give satisfactory performance not only under conditions met at high altitudes but also at sea level and under very high humidity." —"AVIATION," Mar., '44.

Plane Insulation 100

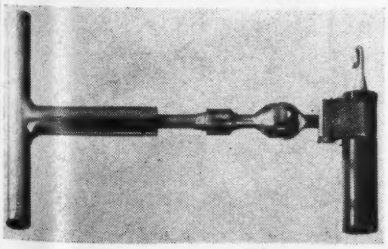
Acoustic Div., **Burgess Battery Co.**, Chicago, announces marketing of processed cat-tail down for insulation in planes. Under name of Typha, material is available in loose or blanket form following long experimentation in obtaining fluff ingredient from cat-tail spikes. It is termed light in weight, buoyant, water-resistant, and sound-deadening.—"AVIATION," Mar., '44.

Aircraft Rubbers 101

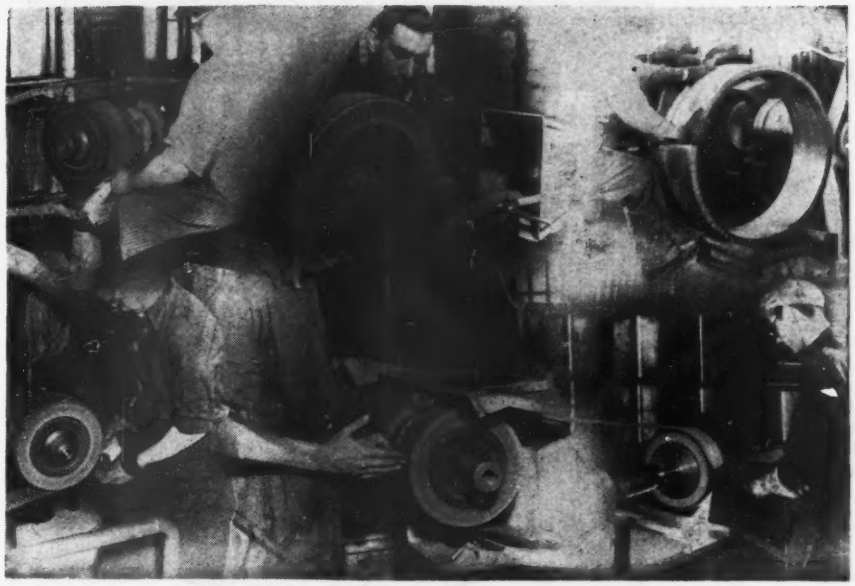
Los Angeles Standard Rubber, Los Angeles, gives performances of two of its products as: Neoprene based E-3 tensile strength 1,500 psi., elongation of 300 percent, and flexibility to −85 deg. F.; N-1 for fuel container fittings, moldings, and gaskets has tensile strength of 1,500 psi., elongation of 225 percent, and resistance to temperature drops to −65 deg. F. Designed for maximum resistance to aromatic fuels, N-1 has low swelling properties,—"AVIATION," Mar., '44.

Torque Wrenches 102

Two new torque control wrenches, one designed for attaching angle bolts, other for tightening hose clamps, are announced by **Skyway Precision Tool Co.**, Los Angeles. Torque model, for attaching angle bolts connecting inner and outer wings on aircraft, is usually set for 140 in. lb. pressure but may be adjusted up to 250 or to a lesser tension. It has a toggle action that breaks through wrench



body when torque tension limit is reached. Further use of wrench merely jackknifes toggle. T-Torque model (illustrated) is for tightening hose clamps on fuel and feed lines. It is usually set for 25 in./lb. but is adjustable above or below that pressure. When desired tension is reached, wrench automatically releases. It is designed to accommodate standard flexible extension drives and will soon be available with screwdriver attachment.—"AVIATION," Mar., '44.



These Idlers Increase Production

There are idlers and idlers. Some are no good to themselves or anyone else. But, when the simple change over of a polishing lathe to use of abrasive cloth belts by installing an Idler Backstand increases production as much as four times—that's worth looking into.

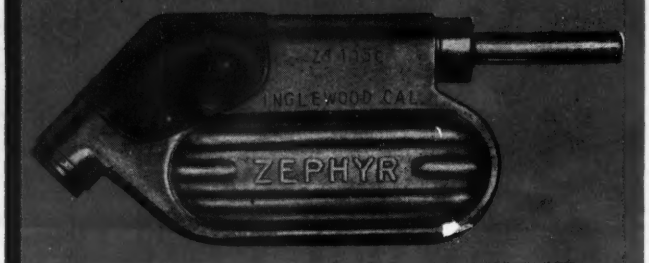
At the wheel: scientifically controlled abrasive cloth cuts faster, cooler, and more uniformly than a set-up wheel; dissipates heat through a constantly changing cutting surface; reduces your loss of polishing grain; makes changes of the fifteen available grit numbers a matter of only a few seconds—slip one belt off, another on.

Between pulleys: you have the facilities of a flexible belt for sanding and polishing tubes or rounds, or a platen may be set up for flat grinding. With factory-made Metalite Cloth Belts you have assured greater cutting speed plus uniformly smooth cutting action resulting from our even-running Uniflow Belt Joint.

Our Field Engineers are thoroughly equipped to explain the distinctive features of various Idler Backstands now on the market, so easily adaptable to this faster, better, modern method of finishing—the use of technically controlled abrasive cloth.

BEHR-MANNING · TROY, N. Y.
(DIVISION OF NORTON COMPANY)
RELIABLE COATED ABRASIVES SINCE 1872

The Sweetest
"PORK CHOP"
Angle Drill You Ever Saw



Engineered from stem to stern for high speed precision work . . . all parts are interchangeable

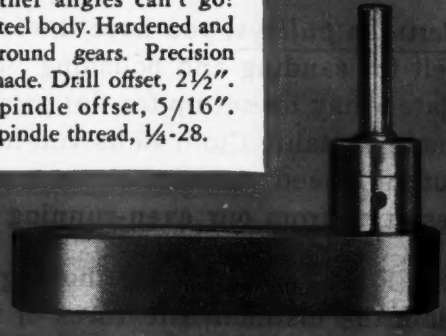
Look it over . . . it's the last word in design for this type of drill. The ribbed body is die cast with oilless type thrust and radial bearings. Enclosed bevel gear drive. Drive shaft and spindle are precision ground and heat treated. This drill wears long and well. Spindle offset, 9/32"; standard spindle thread, ¼-28 (10-32 optional). Order a trial quantity.

Drills shown ¾ actual size.

And a Tough, Long-Wearing
FLAT OFFSET DRILL

Does a good job in close quarters . . . a sturdy tool

This drill moves in where other angles can't go! Steel body. Hardened and ground gears. Precision made. Drill offset, 2½". Spindle offset, 5/16". Spindle thread, ¼-28.



Send for our latest catalog of precision aircraft tools . . . just write your address, title and department on the margin of this page and mail

Write, on your letterhead, for our catalog.

ZEPHYR
High Quality Precision Tools
ZEPHYR MANUFACTURING COMPANY
Factory and Head Office:
201 Hindry Avenue, Inglewood, California
Eastern Branch Office:
609 Stephenson Bldg., Detroit 2, Mich.

Metering Pump 103

Series K fluid metering pumps is being marketed by **Adel Precision Products Corp.**, Burbank, Calif., for aircraft windshield, carburetor, and propeller anti-icing systems and other uses where light fluids are to be discharged up to 150 psi. Equal quantities can be discharged from two outlets by this device which has direct drive and rotary vanes. Dimensions

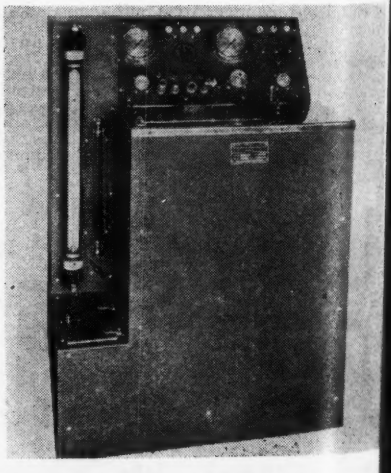
conform to AN standards. Models are now manufactured for delivering 5, 8, 15, and 30 gph. from single outlet and 2.5 and 4 gph. from dual outlets and for a.c. or d.c. 24-v. power at temperatures as low as −80 deg. F. Type illustrated, for 24 v. d.c. with 2.5 gph. dual outlets, weighs 2.65 lb.—"AVIATION," Mar., '44.

Wax-Dip Tanks 104

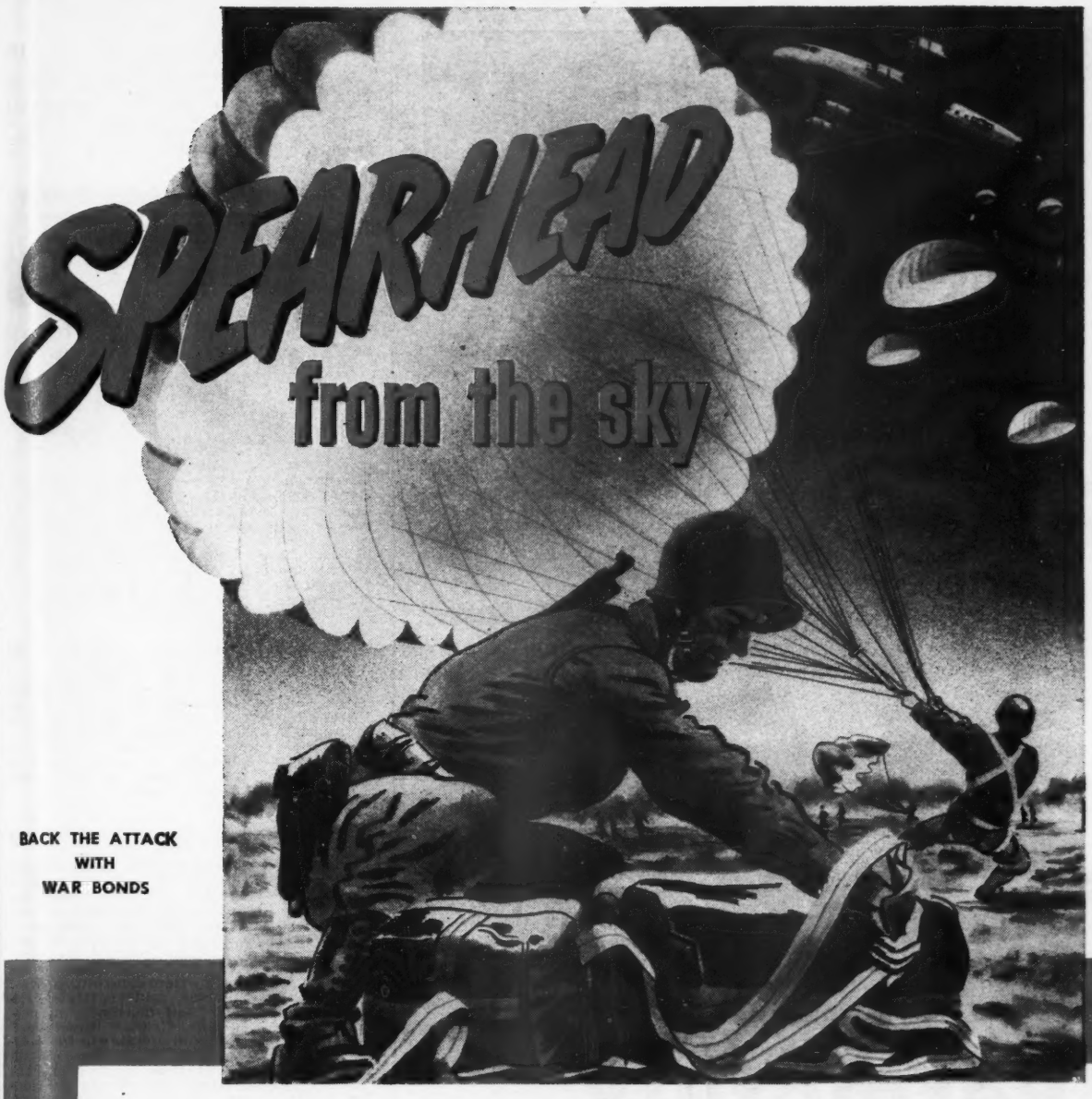
Two new model electrically heated tanks for applying protective wax coatings to parts are announced by **Aeroil Burner Co.**, West New York, N. J. Smaller size has two compartments, one for dipping, other for melting wax for spraying. On latter tank are 1½-in. draw-off cock and spray line outlet. Both compartments are insulated and have individual thermostats for temperature control from 100 to 550 deg. F. Second model is larger with dipping space 25x25x9¾ in. It will melt as much as 24 lb. of solid wax in 50 min. This type also has built-in thermostat for controlling heat within same range as in smaller model. For both of them, company provides dip baskets and heavy duty grills, and both are mounted on casters and operate on 110 or 220 v. Other type tanks made by Aeroil for fixed and portable use are listed in Bulletin No. 268, available on request.—"AVIATION," Mar., '44.

Governor Tester 105

Unit designed for testing and calibrating all types of propellers also makes possible ascertaining governor range, sensitivity, and response. Types which can be checked on this machine, designed by **Liberty Motors & Engineering Co.**, Baltimore, are Hamilton Standard—constant speed controls, single and double capacity governors, anl electric control-



head governors; Curtis Electric—pad mounted, flexible shaft-driven, proportional, and control head governors. On Hamilton Standards, tester operator can determine relief valve pressure setting and pressure cut-out switch operation as well as internal leakage and bursting pressure. Machine, which rolls on casters, has rear doors to facilitate inspection of its units.—"AVIATION," Mar., '44.

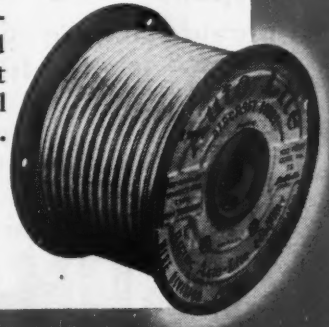


BACK THE ATTACK
WITH
WAR BONDS

Bedlam begins for the enemy. The silent spearhead has struck—according to plan.

Wire and cable have helped carry out that plan . . . wire that helps send and receive messages on the inter-com. . . . wire and cable for ignition, for lights and for instruments that help keep troop and supply ships on split-second schedule.

Information on Auto-Lite aircraft wire and cable should be in your files. Form No. 838 covers low tension wire and cable. Form No. C-503 gives complete details about Steelductor, the high tension wire that is famous for better performance, and economy. A request on your letterhead will bring both Bulletins.



THE ELECTRIC AUTO-LITE COMPANY
Wire Division

SARNIA, ONTARIO — PORT HURON, MICH.

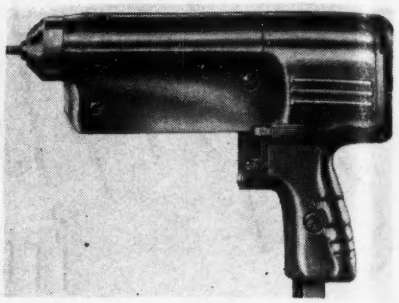
AUTO-LITE AIRCRAFT WIRE and CABLE

TUNE IN "EVERYTHING FOR THE BOYS" STARRING RONALD COLMAN—EVERY TUESDAY NIGHT—NBC NETWORK

SUPREMACY
in the
SKY
Permoflux
DYNAMIC HEADPHONES
. . . their extra sensitivity, wide frequency response and high operating efficiency provide improved intelligibility and greater safety at all altitude levels.
BUY WAR BONDS FOR VICTORY!
TRADE MARK
PERM-O-FLUX
PERMOFLUX CORPORATION
4916-22 W. Grand Ave., Chicago 39, Ill.
PIONEER MANUFACTURERS OF PERMANENT MAGNET DYNAMIC TRANSDUCERS

Rivet Driver..... 106

A new blind rivet driver, pneumatically operated, that drives and bucks in one operation is announced by **Independent Pneumatic Tool Co.**, Chicago. A light at top of handle indicates when rivet has been accurately upset on blind side.



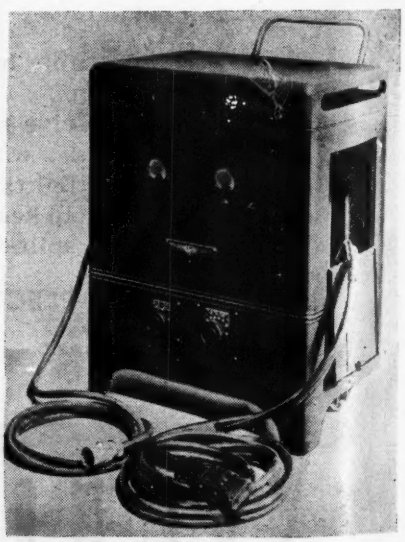
First step of cycle screws a mandrel into rivet; second step pulls back mandrel, upsetting rivet and flashing light; third unscrews mandrel; and fourth shuts off tool. It weighs 4¼ lbs., measures 9½ in. long, has a spindle offset of 7/8 in. and a speed of 1,000 rpm. forward and 2,000 rpm. reverse. It is known as Thor Riv-Driver.—**"AVIATION," Mar., '44.**

Infrared Bulb Base..... 107

In place of usual cementing and strapping of infrared bulbs to their bases, Birdseye Div., **Wabash Appliance Corp.**, Brooklyn, N. Y., has substituted base lining with protrusions which fit into indentations on neck of bulb. Locking is effected by crimping in base. Heat is reported to have no effect on this union. —**"AVIATION," Mar., '44.**

Testing Rectifier..... 108

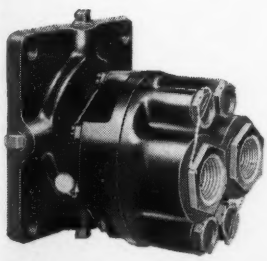
Power for ground testing and servicing of warplane equipment can be supplied by new heavy duty rectifier delivering sufficient current to operate gun turrets. Output can be regulated by knob which rotates a tap switch connected in primary circuit. Voltage control has "no-load" limit that can be set and locked against tampering. Rectification proceed through three phases, and rectifying element consists of "self-healing", magnesium-copper sulfide disks. Sheet steel cabinet, with side compartments for holding cables, has been designed for all-weather work. Handle and 6-in. ball bearing rubber-tired casters are provided for moving unit. Ventilating air is provided by small fan. Standard model, says **Airplane Manufacturing & Supply Corp.**, North Hollywood, Calif., has capacity of 20 to 28 v. at 200 amp. with



d. c. output starting inrush of 1,200 amp.; 400 amp. can be delivered for 3 min. Alternating current rating is 460 v., three-phase at 50 to 60 cycles. Unit can also be obtained for 10 to 14 v. capacity.—**"AVIATION," Mar., '44.**

PERFORMANCE CONTROLS THE AIR

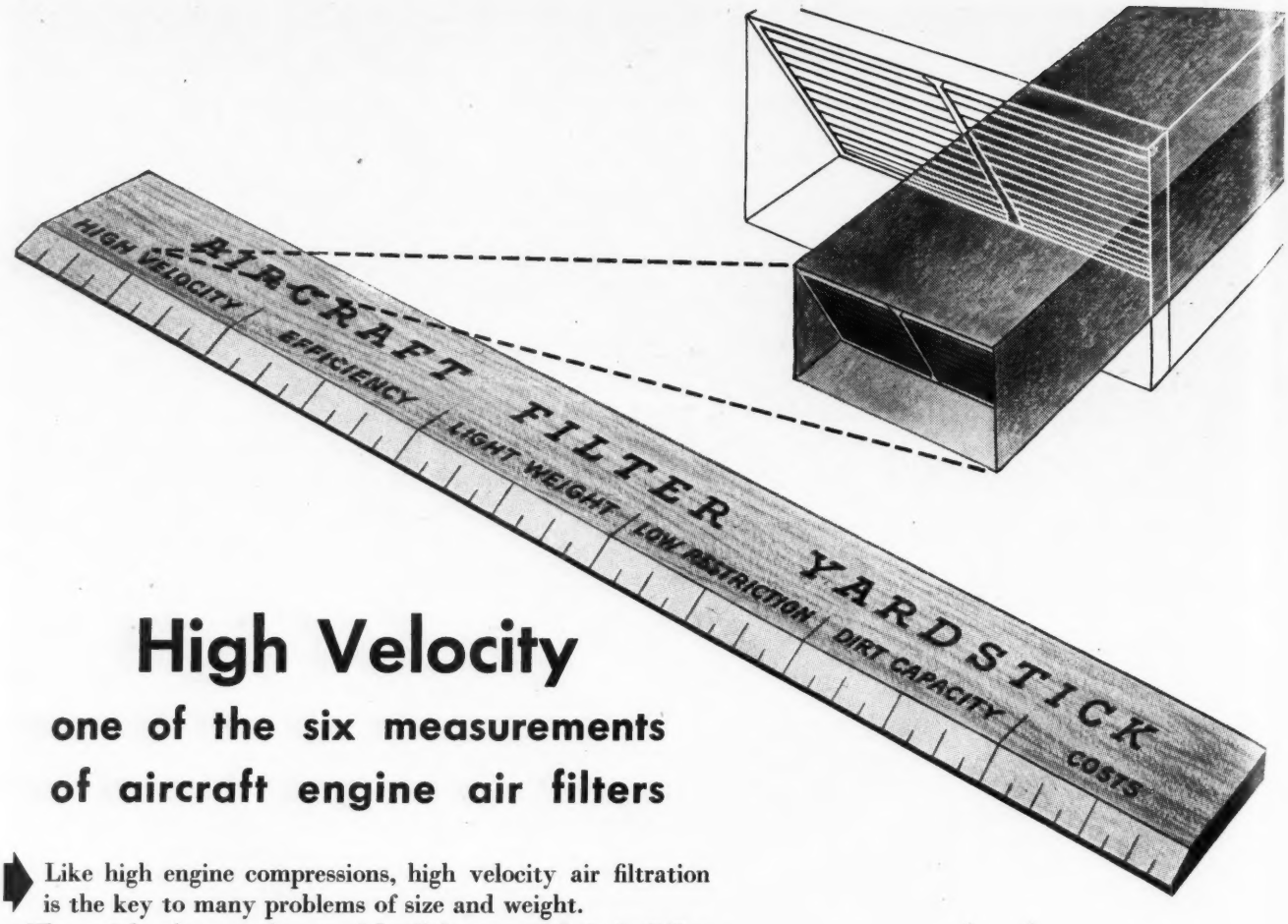
FAIRCHILD *GUNNER*. Where aerial sharpshooters perfect their aim for strafing or shooting down the enemy. Performance is vital in these modern molded plywood planes designed for specialized training.



PESCO "PRESSURE-LOADED" HYDRAULIC PUMP. Heart of the hydraulic system on vast numbers of American planes, this PESCO pump was engineered in response to urgent aircraft needs. Among its many exclusive features are "pressure-loaded" bushings which minimize gear clearance and insure maximum volumetric efficiency regardless of thermal variations or wear. Extremely compact and lightweight, some models deliver pressures up to 3,000 p.s.i. PESCO Products Co., 11610 Euclid Ave., Cleveland 6, O. (Division Borg-Warner)

In Aircraft Hydraulics, Fuel Pumps, Air Pumps, Related Accessories...

PERFORMANCE POINTS TO Pesco FIRST



High Velocity

one of the six measurements of aircraft engine air filters

Like high engine compressions, high velocity air filtration is the key to many problems of size and weight.

The weight that can be saved by light materials in building any filter is definitely limited. The *speed* at which a filter can clean air, however, rests largely on engineering ingenuity and design. As better answers are found to this problem, filters—and the entire induction system—automatically become lighter and more compact.

Air-Maze engineers recognize these potentials of high velocity air filtration, and have led in their development since 1926. Along with improvements in materials and in media efficiency, they have succeeded in reducing filter weight and size enormously by multiplying the velocity at which Air-Maze filters operate efficiently.

Of the six measurements of aircraft filters, high velocity—affecting the size and weight of the entire intake assembly—is one to think of first.

FACTS about aircraft engine air filters . . . types, improvement, performance data. Send now for your copy of "Aircraft Engine Air Filters."

★

VELOCITIES TO 2,000 F.P.M.

★ Air-Maze filters are available for velocities up to 2,000 F.P.M., non-ramming. Those shown are but a few of the many we have designed and built. Write for Bulletin 113.

AIR-MAZE CORPORATION • *Engineers and Manufacturers* • **CLEVELAND 5, OHIO**

Representatives in Principal Cities • *In Canada:* **Williams & Wilson, Ltd., Montreal, Quebec, Toronto, Windsor**

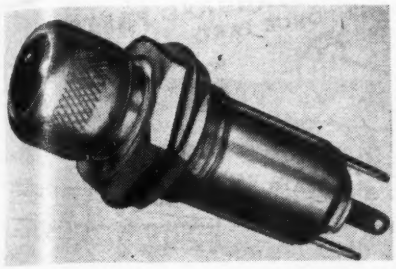
ARMY E NAVY

AIR-MAZE

SPECIALISTS IN AIR FILTRATION

Test Light 109

Built-in break-before-make control which prevents actuation of circuit solenoids and relays is feature of new test light. It is made of aluminum, measures



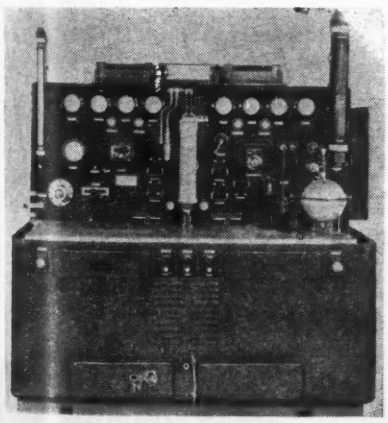
2¼ in. from terminals to jewel, is designed to be mounted in 5/8 in. hole in 3/8 in. panel, and weighs just under ½ oz. Intensity is dimmed by turning, and light is operated by pressing. Standard color jewels are supplied by **Searle Aero Industries,** Orange, Calif.—"AVIATION," Mar., '44.

Spray Booth Coating 110

Easy removal of paint which strays onto conveyor parts during spraying is reported possible with use of Boothcote spray-booth coating manufactured by **Harris Soap Co.,** Buffalo, N. Y. Product is applied to conveyor parts with brush or spray apparatus. After paint spraying operation is finished, coating is stripped off—and surplus paint comes with it.—"AVIATION," Mar., '44.

Test Benches 111

Two types of test benches have been developed by **Hydraulic Machinery,** Dearborn, Mich. One of models, T-116, will develop pressures up to 2,000 lb. for checking short lengths of hose, tubing, and cylinders. Within its 21x28-in. base are motor, pump, pressure release and shut-off valves, pressure and oil level gages, and baffles and filters. This bench is 40 in. high. Model T-110 (illustrated), designed for instruction in testing general aircraft and machine tool hydraulic apparatus, can also be used in checking general equipment. Oil flow meters are calibrated in gallons per minute; power for testing various types of pumps is supplied by variable speed fluid motor. There are also one aircraft and two commercial cylinders, speed control valves, remote control pressure valves, electrical and manual directional valves, and pressure and oil temperature gages. Pumps include one for variable



delivery with maximum pressure of 1,500 lb., one combination type delivering 1,000 lb. maximum, and a 2,000-lb. constant delivery type with take-off ports and aircraft spherical accumulator located on instrument panel or enclosed in bench. Push buttons control all electric motors and valves, and pilot lights, including a master for main circuit, indicate when circuits are closed. Two cable jacks for checking electrically controlled hydraulic valves are imbedded in panel above work bench measuring 29x84 in. Unit itself is 40x84x77 in.—"AVIATION," Mar., '44.

Checking the alignment of contact holes in a new insert.

Cannon Quality Control

colossus of little things

To our customers Cannon Quality Control means *one thing* only —the absolute dependability of Cannon Connectors.

To Cannon men and women, however, quality control means a *thousand things*—the constant vigilance to innumerable details —the continuous betterment of design—the alert scrutiny of materials — the steady improvement of machines, tools and methods—the checking, testing and checking again of all the parts as well as the completed product.

It means following the product into use to measure it against the demands of service. And so Cannon Quality Control results in what you know and appreciate—the uniformity of excellence throughout the multi-millions of Cannon Plugs in service today.

New Training Film on Soldering

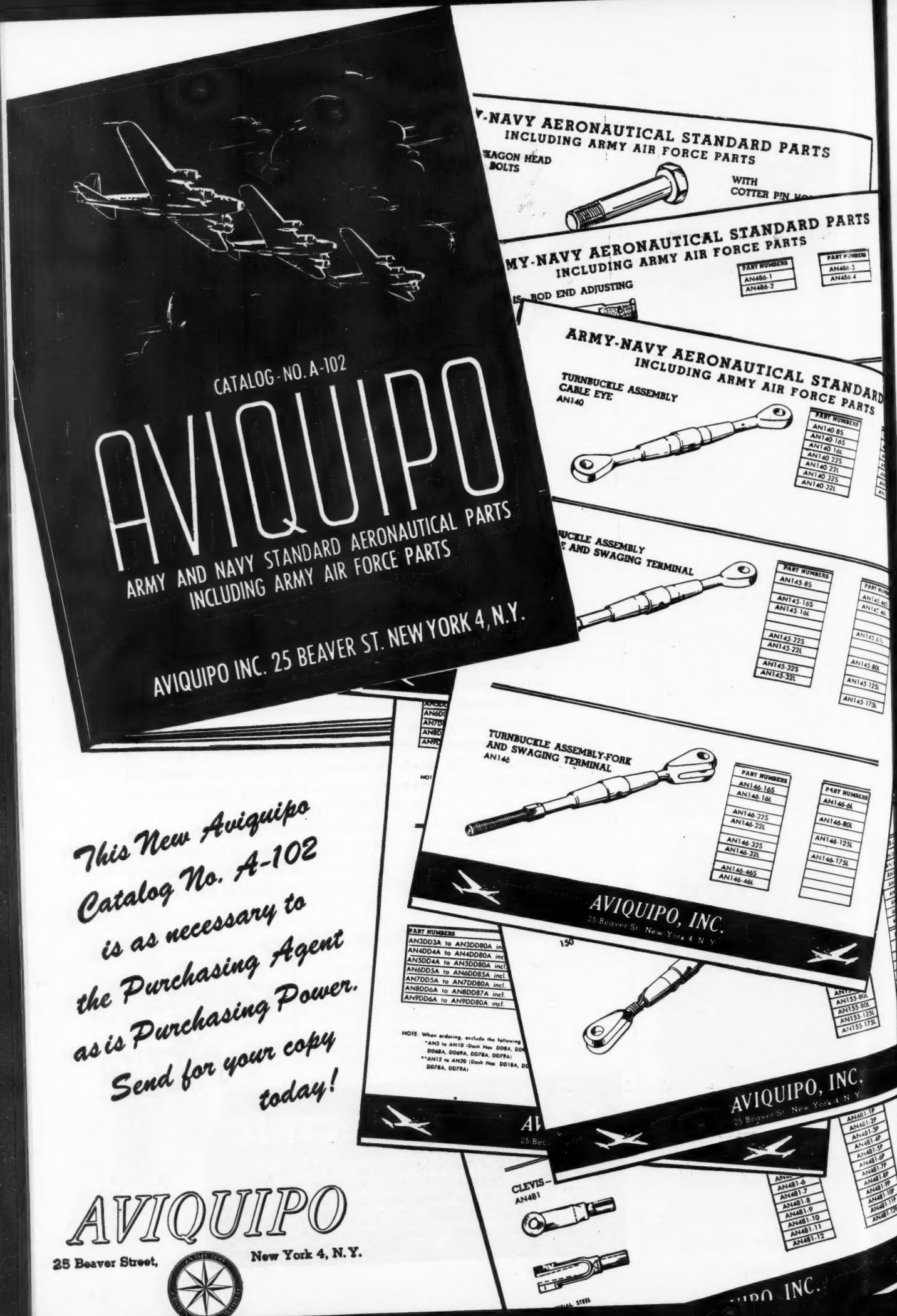
An important training aid "Soldering Tips," a 25 minute slide film with sound, giving step-by-step procedure in soldering contacts... a companion film for "The Quick Disconnect," available on request. Contact your Cannon Representative or write direct to the Cannon Factory, Dept. A-110.

CANNON ELECTRIC

Cannon Electric Development Company,
Los Angeles 31, California

Canadian Factory and Engineering Office:
Cannon Electric Company, Limited, Toronto

Representatives in principal cities — Consult your local telephone book



This New Aviquipo Catalog No. A-102 is as necessary to the Purchasing Agent as is Purchasing Power. Send for your copy today!

AVIQUIPO

25 Beaver Street, New York 4, N.Y.

The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington — HERB POWELL, New York

January Plane Production Was 8,789, Poundage 90.3 Million; Trends Forecast

Washington (AVIATION Bureau)—Aircraft production is already bouncing against the numerical ceiling. The schedule for '44 is 113,000, but Charles Wilson, chairman, Aircraft Production Board, estimates the industry will produce 100,000 units. Measured in pounds, however, this year's schedule is 50 percent over '43.

January unit production was 8,789, exactly the same as the November figure and 13 less than December's output of 8,802. Rules have been tightened so that only planes formally accepted by the services can be counted. Bad testing, poor flyaway weather, or minor faults, may cause them to be held out of the totals. About 200 were withheld from the January figure.

Poundage ran up from 85,700,000 lb. pounds in December to an estimated 90,300,000 lb. in January—that is, with spares included. The '44 schedule calls for an increase of 50 percent over '43, which will mean building up the poundage total to nearly a billion.

Meanwhile, the unit rate of production will run pretty level, perhaps never reaching the 10,000 per month rate which the government once aimed for. In fact, the numerical monthly rate may possibly drop off. WPB is concerned about future public reaction to the unit figures. Wilson recently issued a statement obviously preparing news readers for disillusionment on the numerical record and trying to educate them to read reports of the nation's air power in terms of pounds.

The APB chairman said that if total production is continued in terms of 1942 unit weights, 1944 output will be equal to about 167,000 planes. Using "with spares" figures, he said that the average unit weight in 1941 was 4,440 lb.; in 1942 6,110 lb.; in 1943 8,630 lb.; and in 1944 it will be approximately 10,000 lb.

Wilson said that 1944 schedules place emphasis on most-needed combat types, all of which are larger than the models they supplant. He stated that the trend will be toward reduction of trainer and other types, with an increase in combat types, including the B-29 and other models to be put into production.

WPB investigators are already at work on estimates of the probable cutback on Germans-quit day. They disagree—all the way from 30 to 60 percent of the rate. These cutback expectations apply only to the Army, not to the Navy.

Military Airport Disposition Poses Postwar Problem

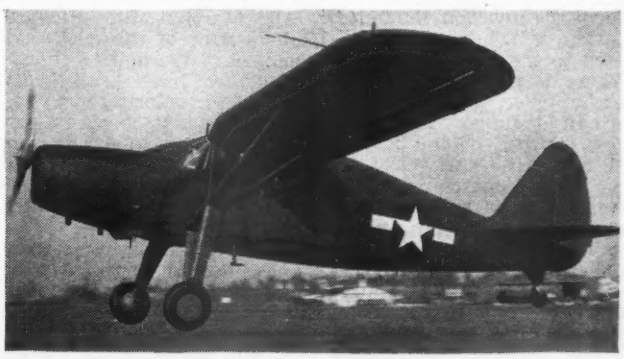
Among the billions of dollars worth of goods and properties to be disposed of after the war will be a few of the airports built by the CAA, also some of those constructed by the Army and Navy.

Disposition of the ports, mostly within the limits of the United States, is under consideration by CAA, the armed forces, and congressional committees studying postwar problems. The Civil Aeronautics Authority hopes that it will be assigned to handle the military fields as well as its own. Most of the CAA ports are located so that municipalities and counties can use them.

Some fields may pass into the hands of private management for municipal service, but all will be regulated by local and federal authority. It is impossible to determine how many fields the Army and Navy will want to retain; this will depend upon what kind of peace treaty eventually is negotiated. So far, no one has found any important alternative use for an airfield. In some cases, where a municipality acquires a second airport, one may be used for cargo and the other for passengers, with mail at both. CAA is against long-term leases because a bad lessee who could not be displaced might hurt the community.

2,000 "Havocs" to Russia

Douglas has been authorized by military authorities to announce delivery of more than 2,000 attack bombers of the A-20 "Havoc" type to Russia, and more are on the way. They are also being delivered to the RAF and the AAF in increasing numbers. Deliveries to Russia are via the Alaskan land-bridge.



UC-61 GETS MORE POWER

Undergoing flight tests is Fairchild UC-61K, modification of four-place UC-61A cargo-utility plane. New model is powered by 200-hp. aircooled inline Ranger engine in place of 165-hp. Warner radial. Over-all length has been increased from 23 ft. 10 in. to 25 ft. 10¼ in. General construction, interior arrangement, and other details, are same as on UC-61A "Forwarder" (see Sketch Book of Design Detail, this issue) reported in liaison, personnel, and cargo service in England, Australia, and other fronts.

Coming Up

Mar. 25 to Apr. 1: 1944 Aviation Exposition; Greater Twin Cities Chapter of NAA; Minneapolis Auditorium, Minneapolis, Minn.

Mar. 26 to Mar. 28: American Society of Tool Engineers; Bellevue Stratford Hotel, Philadelphia, Pa.

April 27: National Light Aircraft Meeting; Institute of Aeronautical Sciences. The Horace H. Rackham Educational Memorial, Detroit, Mich.

Army Flight Training Cut

Among cutbacks and cancellations which are displacing war workers and industries with increasing frequency is the termination of CAA War Training Service upon the advice of the Army Air Forces. All training in secondary, cross country, Link, instrument, and flight instructor courses of CAA-WTS is to be discontinued.

Approximately 26,000 men were taken into the Air Corps Enlisted Reserve, through CAA, for this training. On Dec. 30, only 4,176 were still in training, the rest having gone to active duty. The disposition of those still remaining is up to the Air Forces.

Meanwhile, AAF released 70 colleges and 14 civilian contract schools in the CTP for return to their civilian uses. Building of the AAF is virtually completed; from now on AAF will train its own replacements.

R. McLean Stewart, executive director of Training for CAA, also the various pilot and small plane associations, are urging Congress to provide for a CPT continuation.

Glider Institute Established

Formation of The Glider Institute of the Americas, with offices at 411 Defense Bldg., Washington (6), is announced by O. T. Wingo, Jr., executive v.-p. of The Columbia Survey.

Nine glider manufacturers are reported to have signified their interest in this new glider-field information "clearing house."

America At War

Aviation's Communique No. 27

ANGLO - AMERICAN - CHINESE FORCES have taken in the slack and the squeeze is on Japan. Premier Tojo recently told his people that everything depends on airpower, that while Jap production of planes had increased 100 percent the past year, more aircraft are necessary. He got down to cases and said that a hair's breadth of power on one side or the other might be the difference between defeat and victory.

Tojo is wrong of course. The margin of superiority is wide on the Allied side. Japan has the population and materials plus the advantage of fighting on her home field, but technology, especially in aircraft and productive facilities, is far inferior to that of the United States and Britain. The Jap cannot keep even in aviation because he has to copy.

If Jap airplane production has doubled, as Tojo said, it is possible they are now getting 2,000 or more per month of all types. Recent Washington reports, however, put Nipponese output at about 1,200 a month. The time will come, if it has not already, when Japan's airplane output will pass Germany's, where production is being decimated by bombing and disruption of services. But whatever building rate the Japanese may have or achieve will be of little avail against the myriad planes which the Allies will fly against them.

Liquidation of the Marshalls looks like a drive on the "direct" island skipping run to Japan. The Solomons and Gilberts are already in Allied hands, and Rabaul should be finished early.

Push Into the Carolines

Next hard job would seem to be the Caroline Islands, centered by the great Jap naval base at Truk. That bastion has already taken a blasting which, into the bargain, blew two leading Nip war lords out of their jobs. Meantime, we've taken Eniwetok, and likely other islands are falling as we write.

Eleven or twelve hundred miles north of Truk is Marcus Island, owned and occupied by Japan—about 1,200 mi. from Tokyo, a feasible distance for unescorted bombers. That probably puts Marcus out of effective range of Japanese land-based aviation, while it would allow long-range Allied equipment to deliver fairly large loads of explosives on the land in which "soldiers die like flowers." But Marcus is only a square mile or two in area, and it cannot base an effective force of land planes.

Closer to the Jap mainland are the islands of Ogasawara Shoto, only 800 mi. distant, a nice run to give Tokyo the "Hamburg" treatment. But these islands also appear to be too small; and Jap aviation could make it hot for Ogasawara, or any islands of like distance from their home bases.

Also about 800 miles from Japan is big Formosa island, just off the coast of China—probably not as easy to capture as a piece of the China coast itself. Luzon, in the Philippines is big too, and at 1,200 mi. from Japan, is a practical distance, especially for B-29s.

Decimation of shipping comes nearer than any other to being a one-way method to put the kill on Japan. Already the Allies have laid more than 1,025 ships on the bottom, about one-third of all the Japs had. It is clear they are unable to replace these losses because they are resorting to barges, which are slow and costly in troops.

The Press on Germany

In Europe, still the big show, the main event is complete liquidation of the Luftwaffe, which Lt. Gen. Carl Spaatz says may be expected some time this summer if the weather is good.

The German air force is showing increasing weakness; only over vital points do Nazi airmen come up and fight with a will. Despite bombings the Germans have managed, according to British reports, to add about 1,000 fighters to their defensive air force.

The time when the Luftwaffe can be run out of the air will partly answer an important question. On invasion day, the generals will have to decide how much allied airpower to leave on strategic operations against German productive works, and how much to divert to tactical support of the landing forces. If there is no German air force left at the time of the invasion, much less aviation will have to be diverted to tactical work.

There is no reason to suppose, however, that absence of German air support for ground forces resisting on the beaches will make the task easy for the Anglo-Americans. The latter have air superiority in Italy, but the job certainly is not easy.

One should add, though, that aviation *can* make ground operations easy to the point of negligibility, as in the case of the landing just below Rome. The Germans not only failed to offer resistance; they didn't even know about the landing till hours after it was accomplished. The reason was that their air observation had been completely excluded from that region for a time before the Americans drove for the shore.

Allied bombers recently have been feinting at one city and then hitting another one, to throw the defense off balance. Another trick, developed recently, is to hit one city twice the same night, as was done first to Berlin.

Air Marshal Sir Richard Hallem-Peck of the RAF says about 20 of Germany's industrial cities have been badly crippled for a long repair period, and about 50 others are well on the way to destruction. Gen. Spaatz says the aerial assault knocked out about 40 percent of Germany's planned fighter strength during 1943.

These estimates of destruction seem to be borne out by the weakness of the German air force and by the chastened mutters from the Reich masters, but power of Nazi arms in Russia and Italy seems to indicate no lack of essential materials, men and fighting spirit. There are still plenty of airmen and laymen who believe military aviation has been oversold, that war leaders have been taken in by the thrilling noise and glamour of combat flight.

When you think of the sinking of a destroyer by one little airplane, of the wrecking of a harbor by a dive bomber squadron, the billions of dollars in damage to German cities, you seem to have a solid answer to any such doubts. Military aviation seems to be saving Allied lives in hundreds of thousands. If so, its value is well clinched. Nevertheless, when the doubters say that airplanes don't sink ships and burn cities often enough to justify the great cost, they should be listened to. Those who claim that aviation saves large numbers of soldiers' lives will have to wait and see how the wars are finally won before they can prove it.

New equipment in Europe recently featured the North American P-51B, in the long range class with the Republic P-47 and the Lockheed P-38. Apparently the P-51 retains high performance, for dispatches say it takes over the escort job as the bombers arrive over the target. All of the fighters are now doubling as bombers when the job requires it.

Curtiss-Wright Reports BUOB Campaign Results

After six months, the Curtiss-Wright BUOB (Back Up Our Battleskies) campaign has achieved an exceedingly high goal.

Facing manpower shortages with an increased need for personnel, emphasis was first placed on near-perfect attendance, and time saved through the drive was judged to be enough to build nearly 300 fighters. Rate of absenteeism dropped to 3.34 from over 11 percent.

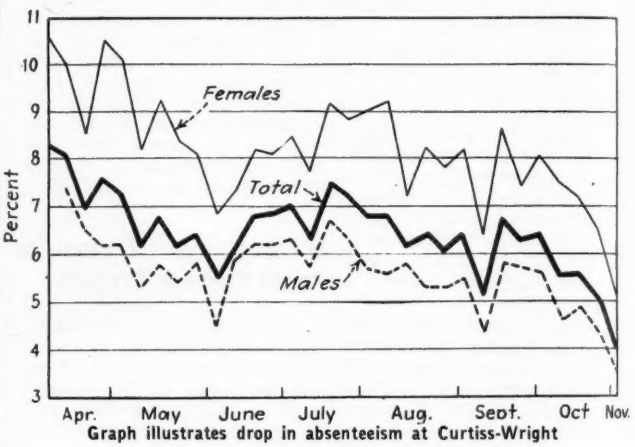
Careful records indicated how outside influences affected attendance, so special drives were organized to combat the effects of such cases—pre-Easter shopping and the like.

Suggestion systems brought an increase of over 25 percent and an even greater "up" in the amount of acceptable suggestions, pointing toward the 100 percent Production-Soldier Award. Buffalo Plant turned in over 2,700 suggestions, but this figure was soon beaten by St. Louis, which led the nation with over 5,000.

Then Columbus stepped up the figures to 7,000, the highest to date. Many of these suggestions h ve meant 1,000 percent departmental production increases.

Quality campaigns stressed reduction in scrap and reworking. Result was 37½ percent rise in rating at Columbus, with Louisville jumping one rating in Army classification.

In safety drives, Louisville dropped the accident rate to one-third national average. St. Louis had a 25 percent drop



Graph illustrates drop in absenteeism at Curtiss-Wright plants during first six months of BUOB campaign.

in frequency and 40 in severity. Rate at Columbus fell to 60 percent of six months before.

Share-the-Ride drives raised passenger averages to 3 and 3½ per car by using windshield stickers and display boards in the plant.

Sixty-odd other firms, many Curtiss-Wright subcontractors, participated in the drive, with excellent results paralleling those obtained at Curtiss-Wright.

★ SPOT CHECKING ★

The **huge** Martin "Mars" 70-ton cargo plane, converted from Navy patrol bomber, which recently set world records in range, load, and gross lift, recently completed its first 4,700-mi. trip to Hawaii in 27 hr. 26 min. total flying time.

State Department reorganization does not change the functions of the Aviation Div. Whereas the Shipping, Telecommunications, and Aviation divisions formerly reported to Tom Burke, chief of the Transportation & Communications Div. (who is now an American Expert Airlines v.-p.), they now report to A. A. Berle, Assistant Secretary of State for Transportation & Communications. Burke's old office may be discontinued.

New safety record: The 16 domestic passenger carrying airlines flew about 1,650,000,000 passenger miles with only two fatal accidents and 23 fatalities in 1943, averaging 1.4 fatalities for each 100,000,000 passenger miles. This '43 record was the best since 1939, when the figure was 1.2.

Little airports: Personal Aircraft Committee of the Aero Chamber of Commerce is whipping up a community campaign for convenient small fields all over the country to increase utility of private airplanes. John M. Hagen is Airport Project Chairman.

18 hr. to the Alps: Among the several European countries seeking to establish airlines to the U. S. will be Switzerland, which is proposing an 18-hr. non-stop run. A big new airport for intercontinental traffic is being planned and existing fields will be improved.

CAP officials tell their members to stay out of election and legislative politics. Industrial squadrons are being formed to give aircraft workers and civilian employees at Army fields practical training in aviation and military subjects.

Coast Guard engineering officers have been at the Glenn L. Martin plant in Baltimore for indoctrination in the maintenance and repair of gull-winged PBM-3 "Mariner" flying boats, which are going into Coast Guard service.

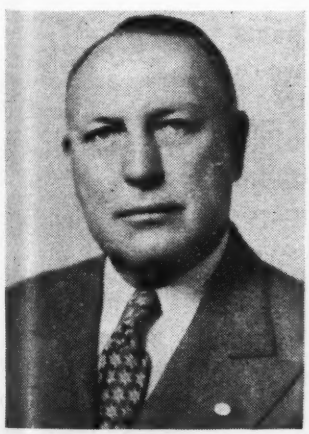
Aerial photographs can reveal to the trained engineer soil characteristics which may be all-important in the choice of an airport site, says CAA's Airport Development Section, reporting progress of a CAA-sponsored research project at Purdue University. This method has been tested successfully at some 25 CAA airport construction jobs, and it promises to be valuable in foreign operations. Texture and drainage are revealed in air photos, it is said.

Swedish Air Transport has converted to cargo planes some American B-17's and German Junkers forced down and interned in Sweden, and they want to buy more of both for service to England, the United States, and Berlin.

"Most remarkable": Charles Wilson, chairman of the WPB Aircraft Production Board, said nearly every aircraft company met or exceeded its schedule—"perhaps the most remarkable feature of the January record," said he. Eighty-nine percent of the total were combat types.

New York City, as a postwar air terminal, will equal itself as a seaport, says Oswald Ryan, CAB member.

Re Navy's "Mars" JRM-1: Truman Committee is inquiring into military transport plane program, including Navy contract for 20 JRM-1s. Navy officials made excuse they didn't want any more transport types when asked if they wanted the Kaiser-Hughes wooden flying boat. Commiteee wants to know why Navy now buys the Martin transport.



PROMOTED BY UNITED AIRCRAFT

In realignment of principal officers of United Aircraft Corp., Eugene E. Wilson (left) has resigned from presidency to give his entire time to duties as a vice-chairman. His former position as president is being filled by 40-yr.-old H. Mansfield Horner (right), manufacturing vice-president and P & W general manager since 1940. Also made a vice-chairman is Raycroft Walsh, former senior vice-president. William P. Gwinn has been raised from assistant to acting P & W general manager. (Photo at left by John Haley.)

The Washington Windsock

By BLAINE STUBBLEFIELD

Want an airport? A few CAA and several military fields are being considered by Congress as surplus war goods, for postwar sale or lease.

People are still talking around here about whether the aircrafters can hit the postwar market with a modernique automobile while Detroit is still in the process of resuming 1942 models. No decision.

The Jap *Zero* still outmaneuvers allied fighters. But with the visiting teams in the Far East scoring 11 to 1 against the Nippos, the maneuver business is small satisfaction to the opposition.

Truman Committee had bad luck picking airplanes for public criticism. Three of them—Curtiss' SB2C and Martin's JRM-1 and B-26—came out in the money.

"New" warplanes are all the rage. But if you take them easy, one at a time, you find that virtually every American plane now in the fight was either in the air or completely engineered before Pearl Harbor.

For 5000 yr., at least, people have been trying to build machines with which to fly by their own muscle power. Just to be on the sunny side, this department predicts somebody will do it. But practical flight durations are something else.

People moan because the airplane has been turned to the destruction of life. Maj. Gen. Ralph Royce says our military aviation is saving life by winning the war with less hand-to-hand combat.

Flying boat vs. landplane argument is getting hot in this town. FB fans are sure boats are most efficient in big sizes. When that is decided, debaters will have to double back and determine whether mammoth passenger airplanes are wanted or not. Many standard experts say the 50-passenger size is big enough; travelers will want frequency of service.

Persons who have seen inside the wings of Kaiser-Hughes' colossal flying boat say it is impressive timberwork. Official and unofficial airdom are burning with curiosity to see how it turns out.

Nearly everybody, including some hardboiled air operators, expect early brilliant success of airline aviation in the postwar years. But the cold-fact engineers keep saying that the cost per ton-mile is a serious limitation now and that postwar planes will be pretty much the same as prewar types. According to them, achievement of cheap rides for passengers and packages is uphill business. Snappy new services and low rates by trains, buses, and ships won't make it any easier.

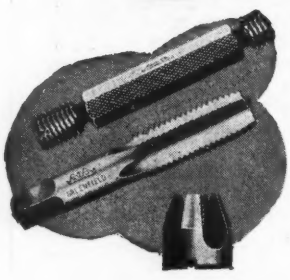
Gen. Arnold praised aerial map makers, gave the Fairchild Award to Lt. Col. Gerald Fitzgerald for best contribution to the famous trimstrogon mapping method by which 5¼ million square miles of the United States and territories have been mapped since Pearl Harbor. He also is credited with the organization, operation, and supervision of all Army units in this method during 1943.

World's first Institute of aviation psychology is to be opened at the University of Tennessee. It will carry forward the program of research on the human factor in aviation initiated in 1939 by the CAA.

Planning for the 1944 Second National Aviation Clinic, at Oklahoma City, Nov. 11-15, is under way; Steadham Acker, manager of the Birmingham Airport and NAA councilor for Alabama, has agreed to be director; William P. Redding, NAA treasurer, will head the credentials committee.

UAL has undertaken the training of Naval Air Transport Service mechanics at company's

THE WOUNDED PLANE THAT *Flies* AGAIN



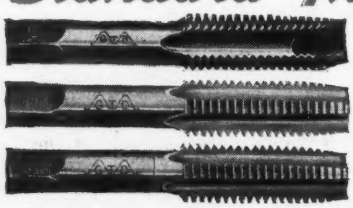
The Germans and the Japs do bring down some American planes — but they'd better be sure they fall in enemy territory. Otherwise, many of them have a way of coming up again, to do battle once more.

The damaged planes — called "hangar-queens" — are kept intact, till their undamaged parts are needed to repair another plane.

What makes possible this free interchange of parts is that miracle of modern manufacture which we're prone to take for granted — STANDARDIZATION.

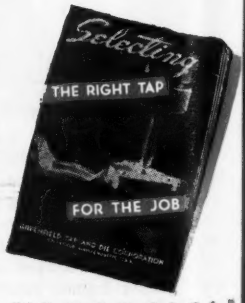
The striking story of the hangar-queen, made possible by standardization, only highlights its benefits to the world in *time of peace.* For not until the use of interchangeable parts made mass production possible did all the people begin to share the comforts formerly available only to the few. *And the end is not yet.*

Standard Threads - SAVE TIME - SAVE MONEY!



GUN TAP
●
CUT THREAD TAP
●
GROUND THREAD TAP

Here are 3 different types of Tap, all of the same size. One of these will best suit your requirements. You'll save money on your work if you first determine which of these types you should use, and thereafter specify this type for that job. This is "Standardization" in practice.



GREENFIELD TAP AND DIE CORPORATION GREENFIELD MASSACHUSETTS

flight training center at Oakland, Cal.

Merced, Calif., city council has approved a contract with the government authorizing the latter to install a $250,000 lighting system at the Merced municipal airport, a 462-acre improvement said to have cost $600,000 without the forthcoming improvement. Sole right to such improvements are to be retained by the city.

Dr. Carlos R. C. Martins, editor of "Diarios Associados," South American newspaper chain, and director of press relations for the Brazilian Air Ministry, toured Southern California aircraft plants early in February under the auspices of Gen. H. H. Arnold.

The 65 test pilots employed by Douglas Aircraft have made more than 50,000 flights, covering 7,536,122 mi., and requiring 40,653 hr. of flying time during the past 2 yr., all without a fatal accident to flying crews. Among these men are Ben Howard, Doug. "Wrong Way" Corrigan, L. E. Bishop, R. F. Bollinger, W. O. Sargent, John Carroll, A. J. Viccallio, Harry Ashe, Bob Lacy, and Mike Bates.

Consolidated Vultee's San Diego Div. has won the rating of "Highest Output Per Man Per Day" rating in the WPB's national production standing, with an average of 8.2 lb. of aircraft produced for every man-day worked in 1943. Second place was 5.8 lb. and third, 4.6 lb.

Buick Div. of GM is tooling for new 14-cyl., 1,200 hp. cargo plane engine similar to P & W R-1830-43 with many parts identical with former models, thus only requiring moderate additions to present mechanical shop equipment.

SAE has received the U. S. Army Ordnance Distinguished Service Award, and it is first professional society thus honored. Award has same rating in engineering as "E" in production field.

Machine Tools Labor Advisory Committee of WPB is studying disposal of postwar surplus tools and machinery, conversion to non-military production, and planning for most efficient conversion methods.

Allentown Div. of Convair is now engaged in conversion of SB2C-1 "Helldivers" for Navy.

Bureau of Naval Personnel, N. Y., needs engineering graduates with aviation experience, 25 to 38 yr. of age, as inspection officers in radio equipment both ashore and afloat.

SAE is organizing Air Transport Engineering Section in answer to requests from air transport officials.

Reconversion opinions vary. Hobart, of Curtis Pub. Co., says many companies can make change in three months; McKinsey Co., of N. Y. and Boston, says at least a year.

American Arbitration Assn. will give its Distinguished Service Award to Chas. E. Wilson, executive vice-chairman of WPB.

Nat'l Assn. of Independent Tire Dealers advises dealers to organize for aircraft tire recapping as postwar business.

Continental Air Lines, Denver modification center has completed a special modification project on NAA "Mustangs".

Uniform Termination A First Conversion Step

By RAYMOND L. HOADLEY

The new uniform article for the termination of war contracts drawn up by Bernard M. Baruch and his postwar adjustment associates marks the "first important step on the road to reconversion" in the opinion of aircraft executives who endorsed the report, issued in early January, as a "termination bill of rights." Almost unanimously, however, they made the reservation that the effectiveness of the proposal depends upon the efficiency with which it is executed and the enactment of legislation deemed necessary to make it fully effective.

The profit limitation of 6 percent on goods was termed "arbitrary," but at least it established a ceiling under which all contractors will receive equal treatment. The profit limitation, these executives feel, also narrows the area of negotiations and thus makes for speedier settlements.

More generous, it was pointed out, is the 2 percent profit to be allowed raw material inventories. This provision legalizes reimbursement of prime contractors for expenses necessary in setting up inventories, contacting subcontractors, and for charges allocable to a contract. The effect of the 6 percent clause will vary, depending on how far above or below this figure a contractor's profit on work in process may be. This provision apparently does not apply to negotiated settlements which are to be reached by agreement as formerly.

Prompt partial payments are termed the objective, but obviously further study and report is needed to assure adequate interim financing. Aircraft manufacturers await later reports that the Baruch Committee promises on subcontracts, payments, loans, and other phases.

CHECK FOR AAF AID SOCIETY

AAF Commanding Gen. H. H. Arnold accepts $3,243 check for Air Forces Aid Society from (center) Robt. H. Hinckley, chairman of committee on arrangements for recent Kitty Hawk 40th Anniversary Committee, and (right) Robt. A. Lovett, assistant secretary of war. Check represented proceeds of dinner tendered Orville Wright commemorating 40th anniversary of Wright brothers' first flight.

CAA FABRIC-TESTING DEVICE

Inspector demonstrates use of new device developed by CAA to replace former feel-of-thumb fabric inspection. Center plunger in tube is pressed down with known force, adjustable for various types of material, after disk pad is placed against it. Effect of this punch (leaving a dimple which soon disappears from healthy surface) then shows whether fabric is rotten or dope brittle.

Autopilot Film

Minneapolis-Honeywell now has a special Walt Disney film depicting its electronic control, the Autopilot. Starting with theory of electronics, it leads through lucid explanations of the circuits which control the unit and which are in great measure responsible for the success of this device on bombing runs. Used in AAF training program, this film instructs service men in maintenance of the device.

Flight Control Centers Established By AAF

A nation-wide network of Flight Control Centers to reduce hazards of flying has been established.

Final links were added with recent activation of centers at Minneapolis, Chicago, Detroit, Cleveland, and Pittsburgh, raising the total located at strategic points to 23.

Coordinated with and using communications facilities of CAA, the centers provide Army flyers in every section of the country with the Pilots' Advisory Service, which gives point-to-point flight protection against any unforeseen weather or other hazards developing after takeoff. Each of the centers is staffed by eight or ten specially trained AAF Flight Control Officers.

Pilots' Advisory Service permits the maintenance of close contact with fliers on cross-country missions, and was conceived to reduce the number of accidents involving military aircraft and personnel. It also is designed to speed the locating and rescue of forced-down planes.

The service is provided by the Flight Control Division of the Office of Flying Safety, Headquarters AAF, under command of Col. George C. Price. Control officers at the various stations are given flight plans of all point-to-point missions within and through their areas, and they plot each according to data from stations in radio contact with the pilots.

GRATON & KNIGHT ENGINEERS

Present.

No. 5 FLANGE PACKINGS (*Continued*)

(Packings Pointers No. 4 discussed the advantages, design features and two typical applications of the flange packing.)

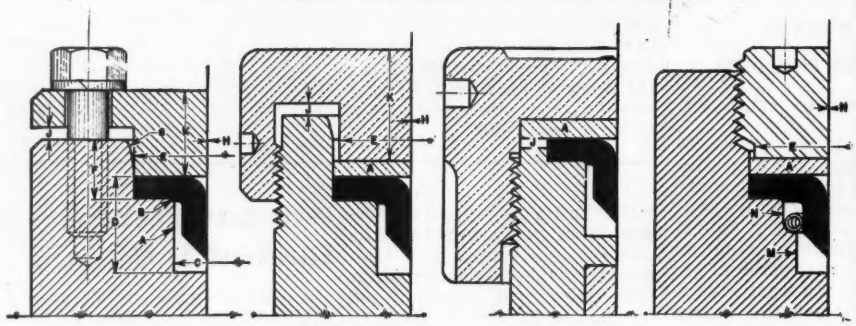


FIG. 1 FIG. 2 FIG. 3 FIG. 4

A. Methods of Attaching Gland

Bolted gland — Fig. 1

Threaded gland, nut-type — Fig. 2

Threaded gland, nut-type with shallow recess — Fig. 3

Threaded gland, screw-type — Fig. 4

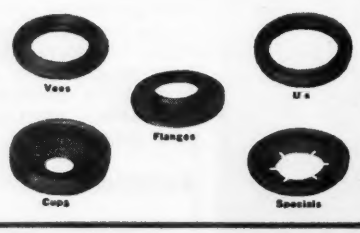
With the type of gland nut shown in Fig. 3, the recess for the base of the packing is shallower than the thickness of the packing. The recess only aids in centering the packing; it should be shallow enough at the packing's outside diameter so there will never be a metal-to-metal contact at "J".

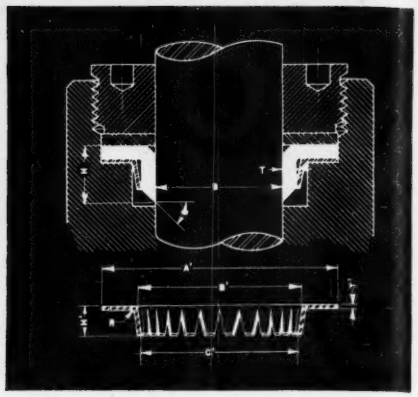
With the type of expander shown in Fig. 4, an extra step is required in the recess at "N". The diameter at "N" should be equal to the diameter of the shaft plus twice the leather thickness plus twice the coil spring thickness plus enough clearance for easy assembly. The depth of the recess at "N" is determined by the height of the packing and the angle of the bevel, but should be deep enough to keep the spring on the outside of the packing's vertical wall, preventing it from slipping over the bevel and becoming ineffective.

Spartan Leather Packings

Graton & Knight's SPARTAN has highest resistance to heat (withstands boil test), and will not dry out hard and brittle. It is acknowledged the top-quality leather in the packings industry.

When your design reaches the "packing point" — or when a packing trouble occurs — call on G&K engineers.





(FIG. 5)

B. Expanders (actually "contractors" in the case of flanges)

1. Finger-type—Fig. 5

The finger-type expander, made from phosphor-bronze or spring steel, is the most efficient of the commonly used types for flanges, but it is usually limited to use on production jobs since its manufacture necessitates a special set of stamping and forming tools for each size of expander.

Due to the many standard variations in dimensions of flange packings, it is not advisable to attempt a set formula for the design of finger-type expander. However, the following general rule will be a helpful starting point.

A = OD of flange packing
B = OD of shaft
H = height of flange
T = thickness of flange
$H^1 = H - T - (\text{Tan. } \Theta \times T)$
$A^1 = A$
$B^1 = B + 2T + 2T^1$
C^1 (in free position) = B
T^1 = optional (to be determined by the tension of the material used and the existing conditions, considering the amount of tension needed)

2. Garter-type—Fig. 4

(to be discussed in a later issue of "Packings Pointers")

C. Washer

On all threaded glands it is advisable to use a protective washer (A in Figs. 2, 3, 4) between the flange and the gland. The washer may be metal, or any other suitable material. Without the washer, the twisting action caused by tightening the gland would damage the packing.

When the washer is used, its inside diameter should be as close a fit as possible on the shaft in order to give the packing proper support. In this case, the fit between the inside diameter of the gland and the outside diameter of shaft does *not* have to be close tolerance.

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★ MILITARY MEMOS ★

Lt. Gen. Ira C. Eaker's new title will be Commander of Mediterranean Allied Air Forces. New force combines old Mediterranean Air Command and Northwest Africa Air Forces, both officially out of existence. American forces will include Maj. Gen. Twining's 15th and Maj. Gen. Cannon's 12th Air Forces. Air Marshal Sir John Slessor is deputy commander.

Rear Adm. Osborne B. Hardison, who commanded aircraft carrier "Enterprise" at battle of Santa Cruz, has been designated chief of naval air primary training.

Maj. Ralph N. Read, AAF, has been named commanding officer of 26th Transport Group of ATC at LaGuardia Field, replacing Lt. Col. Willis H. Proctor, assigned to undisclosed duties. Maj. Read formerly flight captain with PCA, saw action in Pacific, European, North African, and Middle Eastern theatres. Col. Proctor, AA captain in civil life, commanded Transatlantic Sector of former ACFC.

UAL, in the last year, has flown over 800 ATC trans-Pacific flights and 2,400 ATC flights in the Americas. Mileage totals over 11½ million with cargo of over 30 million pounds. Present mileage on ATC routes is over 16,000, or more than twice all regular domestic services.

AAFTC statistics give manpower as 2,300,000 officers and enlisted men, with 100,799 pilots, 20,086 bombardiers, 18,805 aviators, 107,218 aerial flexible gunners, 555,891 ground and air combat crew technicians. About 29,000 training planes of all types are used with an average of 25,600 hr. per fatal accident. Many gunnery technicians have also graduated in armament, radio, and mechnical subjects.

Japan has placed all aircraft manufacture under unified control.

Canadian Notes

By JAMES MONTAGNES

The board of directors of Victory Aircraft, Ltd., government-owned company manufacturing "Lancaster" bombers near Toronto, resigned during January. Heading board was J. P. Bickell, Toronto, mining financier. Reasons given for the resignations was pressure of private business. The corporation is now headed by V. W. Scully, Toronto, who resigned as president of War Supplies, Ltd., a government company handling purchases in Canada by agencies of the United States government.

Canadian Pacific Air Lines carried 70,000 passengers, 2,200,000 lb. of mail, and 9,100,000 lb. of air cargo in 1943, according to preliminary figures released by the company. CPA aircraft flew 6,300,000 mi., an increase of 15 percent over 1942. CPA air transportation employees now number 1,407 compared to 968 in 1942, while school and repair plant employees now number nearly 8,000. The company opened new traffic offices throughout Canada during the year.

A new air route to Alaska is now being surveyed by the Royal Canadian Air Force, Ottawa announces. The new route will be north and east of the present run from Edmonton to Whitehorse, used mainly for military aircraft by Canada and the United States. The new route will use the Mackenzie River airway route of commercial operators, turn east at McPherson, north of the Arctic Circle, then follow one branch of the Porcupine River to Fort Yukon, Alaska.

Canada's aircraft industry has grown from a small business turning out less than 40 aircraft in 1939, to an industry which in '43 produced 4,133 aircraft from trainers to "Lancaster" bombers.

Dominion government recently announced that no new air route franchises would be issued for the duration. Munitions & Supply Minister C. D. Howe stated recently that the government is receiving numerous applications for airline franchises, but that "these routes have been and will be held open until our gallant airmen return from overseas. . . . A franchise for an air route is today the most valuable concession within the gift of the federal government.

By F. H. FULLERTON

Acceptance of "Catalina" patrol bombers, produced by Boeing Aircraft of Canada, Ltd., in Vancouver, soared to a new record in December. Twenty-two of these flying boats were accepted for delivery to the U. S. Navy.

More than 1,000,000 lb. of airmail were flown from the Vancouver airport last year, according to the annual report of William Templeton, airport manager. All phases of airport activity showed phenomenal increases. Weight of mail carried jumped from 637,669 lb. in 1942 to 1,129,124 lb. last year, while volume of air express rose from 189,569 lb. to 229,452 lb.

Expansion of operations at the Boeing plant, Chilliweck, B. C., has been announced with the introduction of a night shift.

Two Societies Organizing

Temporary board to form a National Association of Cutting Tool Manufacturers has been created by resolution of some 150 representatives of 100 such companies meeting in Detroit. Chairman of the nine-man board is W. G. Robbins of Carboloy Co. The board is charged with establishing framework of an association which would consider renegotiation, contract cancellation, taxes, and disposal of surplus equipment. It will have nothing to do with prices or marketing, it is stated in the report.

Organization of The Society of Measurement and Control is underway, according to R. P. Gallien, who asks those interested in assisting to write him at 220 West Fifth St., Los Angeles 13. Membership is open to those actively engaged in development, design, manufacture, sales, utilization, or maintenance of instruments and measuring or control equipment, also research engineers and workers in instrument technology.

DISCUSS GAGE STANDARDIZATION

Hoping that his visit to this country will result in interchangeable, international system for gages and other measuring devices, Stanley J. Harley (second from left), controller of British Ministry of Supply, tool and gage division, meets with executives of Sheffield Corp., Dayton. Left to right, Sheffield Pres. Louis Polk, Mr. Harley, and Sheffield executives Paul Polk, vice-president, W. Fay Alker, research engineer, and Albert Polk, vice-president, inspect gage for checking gun barrels.

★ CALLING NAMES ★

Col. Carl Norcross, AVIATION's managing editor on leave with the armed forces, has been made a full colonel.

W. Paul Eddy, Jr., is appointed materials engineer, Pratt & Whitney Div., United.

Samuel S. Bradley was re-elected chairman of the board of the Manufacturers Aircraft Assn.

Col. Donald C. Swatland, AC, has been named chief of the Procurement Div., AAF Materiel Command.

Josh Lee was sworn in for a full six-year term as a member of the CAB. In 1943, he was appointed by the President to fill the unexpired term of former CAB Vice-Chairman, George P. Baker, who resigned to accept a position in the War Department.

Congressman Joseph W. Martin, Jr., of Massachusetts is the 4,000th member of UAL's 100,000 Mile Club.

Paul F. Collins is now president of Northeast Airlines, succeeding **Samuel J. Solomon** who became chairman of the board. **Robert S. Swain** withdrew as treasurer, but remains as vice-president and director. **H. Le-Roy Swimm** has been elected treasurer, **Milton H. Anderson** vice-president, charge of operations, and **Robert Bradford** a director.

Harry K. Werst is appointed vice-president in charge of manufacturing for Elastic Stop Nut.

John C. Buckwalter is advanced from assistant to plant manager of Douglas Aircraft's Chicago factory. He was project engineer on the DC-4 and helped design the B-19, **Henry G. Moeller** is made general supervisor of subassembly departments at Douglas Aircraft's Santa Monica plant, and **Melvin Huber** is now proposals coordinating engineer, having been promoted from the weight control group which he has headed at Douglas.

Edward J. Ryan is new public relations representative for Pan American World Airways at Los Angeles.

Harry T. Parsons is appointed administrative assistant to C. F. B. Roth, v.-p. in charge of sales.

Irving H. Taylor of Douglas Aircraft was nominated to succeed Lockheed's **S. W. Voorhes** as chairman of the Economic Development Committee of the Aeronautical Chamber of Commerce.

Harold Crary, UAL v.-p. in charge of traffic, and **B. B. Cragg,** director of sales, celebrated their 15th year with the company. Pres. W. A. Patterson presented them with diamond service pins.

Capt. E. Howard Roth, commanding officer of the Buffalo group of the CAP, has received the Aero Club of Buffalo's annual award for "distinguished and outstanding service in the field of aviation in 1943". The award, a silver serving tray, is made annually to a resident in the Buffalo area.

Twin Coach Co. Develops Helicopter

Construction of an experimental helicopter which may be adaptable for the private owner market or for use in public transportation is now nearing completion at the Twin Coach Co.'s Kent, Ohio, plant, it was disclosed recently by Pres. F. R. Fageol.

The bus company, which pioneered in public surface transportation shortly after the close of the first world war, has been converted to war production of plane parts and subassemblies during the present war. It expects to make use of its experience in aircraft fabrication, together with its knowledge of public demands gained through its motor coach manufacturing experience, in the new project.

W. B. Fageol, executive vice president, in charge of engineering for the rotary-winged craft, said that the helicopter now being fabricated is the product of several years of design study. It was indicated that the helicopter would be completed and ready to begin flight tests at an early date.

Aviation Manufacturing

Reconversion Plan for Coast Parts Plants Drafted by APMA; Statistics Detailed

Los Angeles (AVIATION Bureau)—What is going to happen to 3,500 small Pacific Coast aircraft parts plants when war production stops? That question is being given a prominent place on the 1944 program of the Aircraft Parts Manufacturers Assn., according to T. T. Arden, recently re-elected president. Ambitious plans for orderly reconversion to peacetime production are in the making.

Involved in the fate of the plants are 282,000 workers' jobs, $599,250,000 in plant investments, and a potential postwar business volume for the region of half a billion dollars. Concentrated in a comparative handful of cities, closing of a major portion of the 3,500 plants, it is predicted, would inevitably precipitate economic and social consequences beyond the financial means of those cities to solve.

Because the greater part of the nearly $600,000,000 in plant investment is private capital, an estimated 60 percent of which is borrowed from both private and governmental sources, failure to reconvert quickly and continue operations after the war would be a big blow to the American system of free enterprise on the Pacific Coast, in the view of APMA leaders.

Southern California, particularly the Los Angeles area, would be hardest hit. Of the 3,500 plants in the Coastal states, 3,200 are in Southern California and 2,500 of them in Los Angeles area. Prior to the war production expansion, it was stated the Southern California section could boast of only 384 small plants of the type now totaling 3,200.

Investments in small plants are listed by the association as follows: Los Angeles area, $425,000,000; in Southern California, $476,000,000; and in the entire state, $539,750,000. Direct jobs at stake, of persons now employed in the 3,200 small plants, are: Los Angeles area, 200,000; in Southern California, 225,000; and in the entire state, 254,000. Staffs range n size from 3 to 3,000 with an average of 75 per plant.

Preparatory to formulation of an orderly reconversion program, the association's general manager, C. C. Codding, has compiled data on such related subjects as labor needs, labor utilization, absenteeism, turnover, and the trend in unemployment compensation applications since Southern California was declared a "No. 1 Labor Shortage Area."

Although 73 percent of the APMA member companies report they are currently in need of workers, the number required equals only 7.02 percent of current forces. Absenteeism is steadily declining, with one company reporting a record low of 2.3 percent. Turnover, too, is on the downgrade, with reductions as high as 50 percent recorded.

Newly elected association officers, who will develop the reconversion program, are: T. T. Arden, pres. of Grayson Heat Control, president; C. L. Tanner, pres. Hard Chrome Engineering Co., vice-president; H. G. Bley, vice-pres., New Plastic Corp., secretary; and H. C. Thomas, pres., Clarke Aero-Hydraulics, treasurer.

Members of the Executive Committee are: F. W. Wilkins, vice-pres., & gen. mgr., United Aircraft Products; W. C. Buchterkirchen, vice-pres., Gay Engineering Corp.; G. W. Stratton, chairman of the board, Raymond De-Icer Co.; T. E. Colvin, exec. vice-pres., Aircraft Accessories Corp.; and Morris Pendleton, pres., Plomb Tool Co.

Directors in addition to those on the executive committee, are: C. J. Amick, vice-pres. & gen. mgr., Century Metalcraft Corp.; Edmond R. Doak, pres., Doak Aircraft Co.; Lawrence A. Harvey, exec. vice-pres., Harvey Machine Co.; P. D. Hileman, mgr. Thompson Products; Arnold Johnson, mgr. aircraft parts div., Weber Showcase & Fixture Co.; and Hugh L. Clary pres., Clary Multiplier Co.

About That "Black Widow"

Air Force's new night fighter plane, the P-61 *Black Widow* in production by Northrop Aircraft, was announced almost simultaneously with release of the jet propulsion story. But so much excitement attended the j-p release that the *Widow* didn't get its full share of attention.

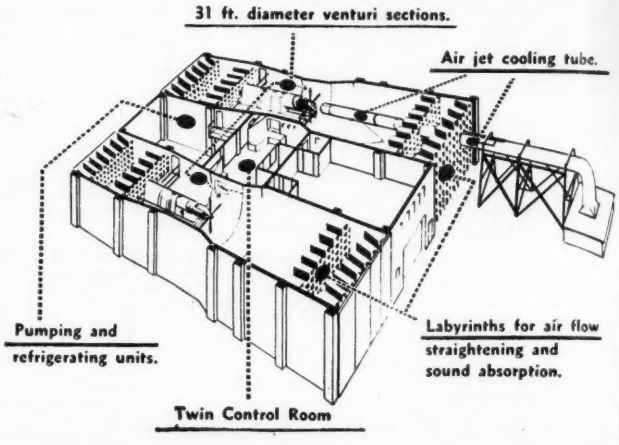
The Northrop fighter is figured to play a bigger part in the war than jet-driven fighters. There is very little difference between a night fighter and any other pursuit plane. The Douglas A-20 has been used for night attack by the British for a long time. A night fighter is usually painted black, and it requires special avigation and fire control equipment.

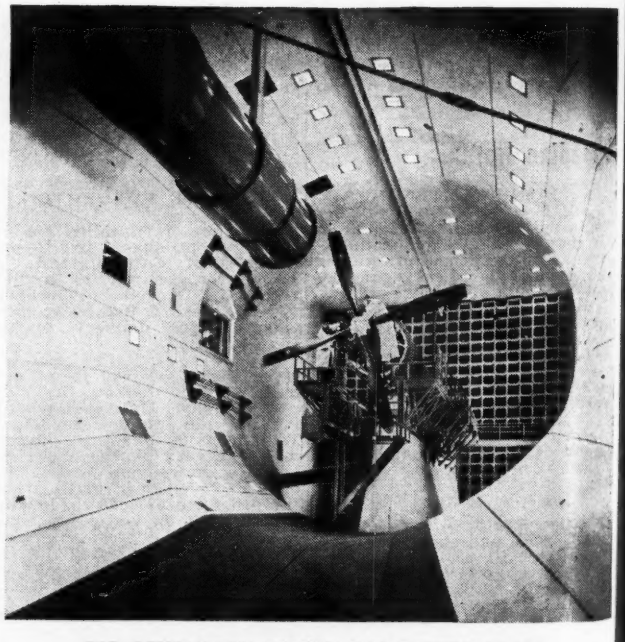
The P-61 is powered by two P & W engines; it has fairly long range and effective speed and climb characteristics. Its major feature, of course, is its new directional and fire control instruments, described as phenomenal. It is heavily armored, and its armament includes "the latest devices for destroying enemy bombers attacking at night."

Air Forces and Northrop began developing the P-61 more than two years ago. Contract for the first model was let in Jan. '41.

New Engine Mount for B-17

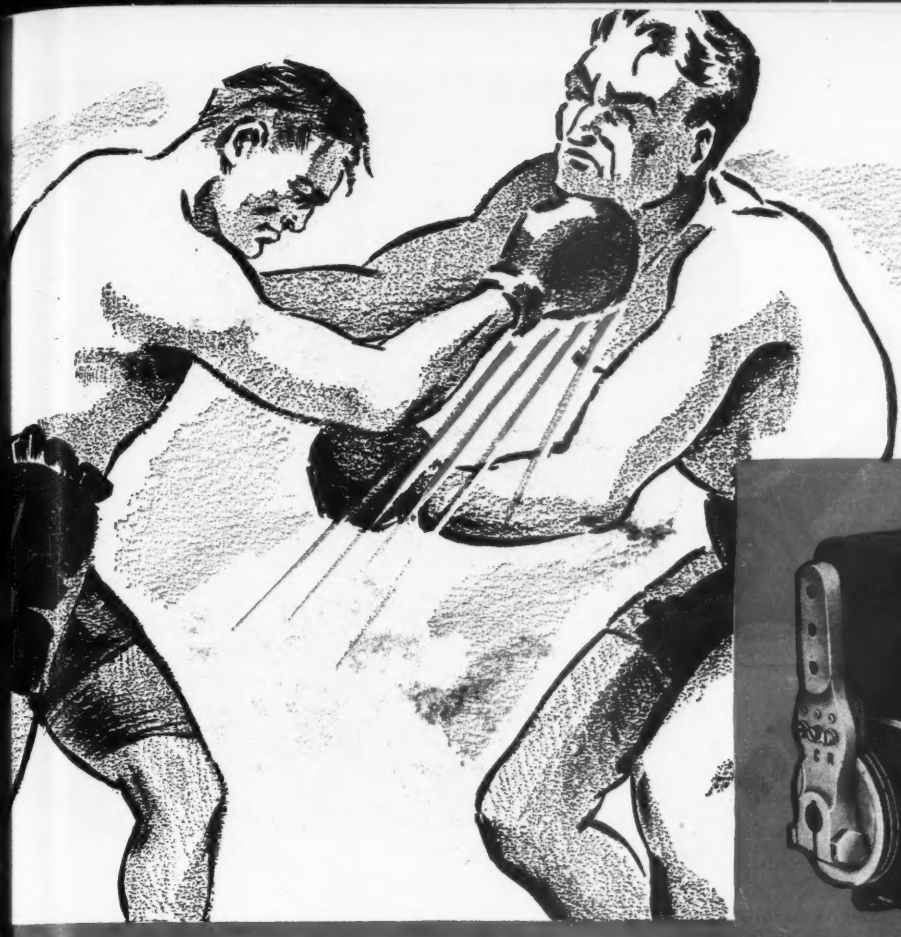
Goodyear announces a new type of engine mount for B-17's—of less weight, requiring less rubber, and reducing vibration—which permits *Fortress* engines to reach their vibration peak much earlier than other types of mounts, sometimes before flying operation ranges are reached. This, it is pointed out, permits more

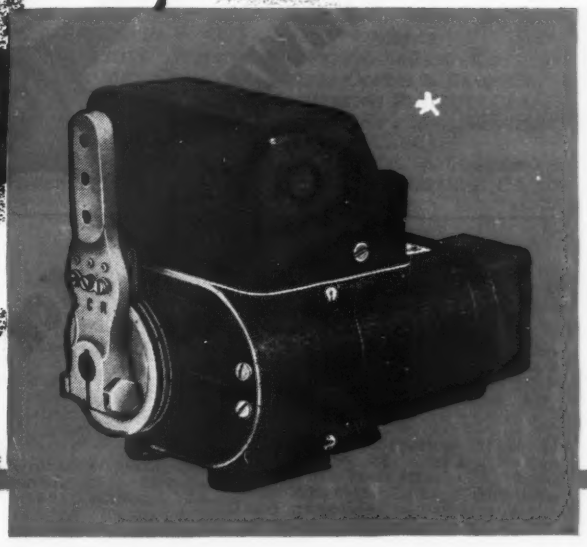

31 ft. diameter venturi sections.
Air jet cooling tube.
Pumping and refrigerating units.
Labyrinths for air flow straightening and sound absorption.
Twin Control Room



FOR DEVELOPING BIGGER AND BETTER PROPS

Test-mount photo and diagrammatic layout of Curtiss Propeller Div.'s new twin test cells at Clifton, N. J., largest privately owned facilities in country, designed to accommodate propellers up to 30 ft. dia. and air and liquid-cooled engines up to 5,000 hp. Unique features include venturi sections between intake and outlet cells, providing best possible airflow, and air jet cooling tubes which can cool either tractor or pusher type engines. In formally opening cells, Robert L. Earle, Curtiss-Wright v. p. and general manager of Propeller Div. said, "We are stepping far ahead of current engine and aircraft requirements." He added that facilities "have been built for the purpose of developing the huge propellers of the future."





POUND FEATHERWEIGHT WITH A 150 POUND PUNCH!

These powerful White-Rodgers aircraft motors combined with White-Rodgers temperature modulation or other control equipment provide a necessary safeguard to both pilot and plane by timing and delivering their punch *exactly* when it is needed — with power to spare!

Available with thermostatic element for air duct or immersion applications, White-Rodgers motor assemblies can be varied in design to meet individual specifications.

Engineering data will be furnished to manufacturers upon request.

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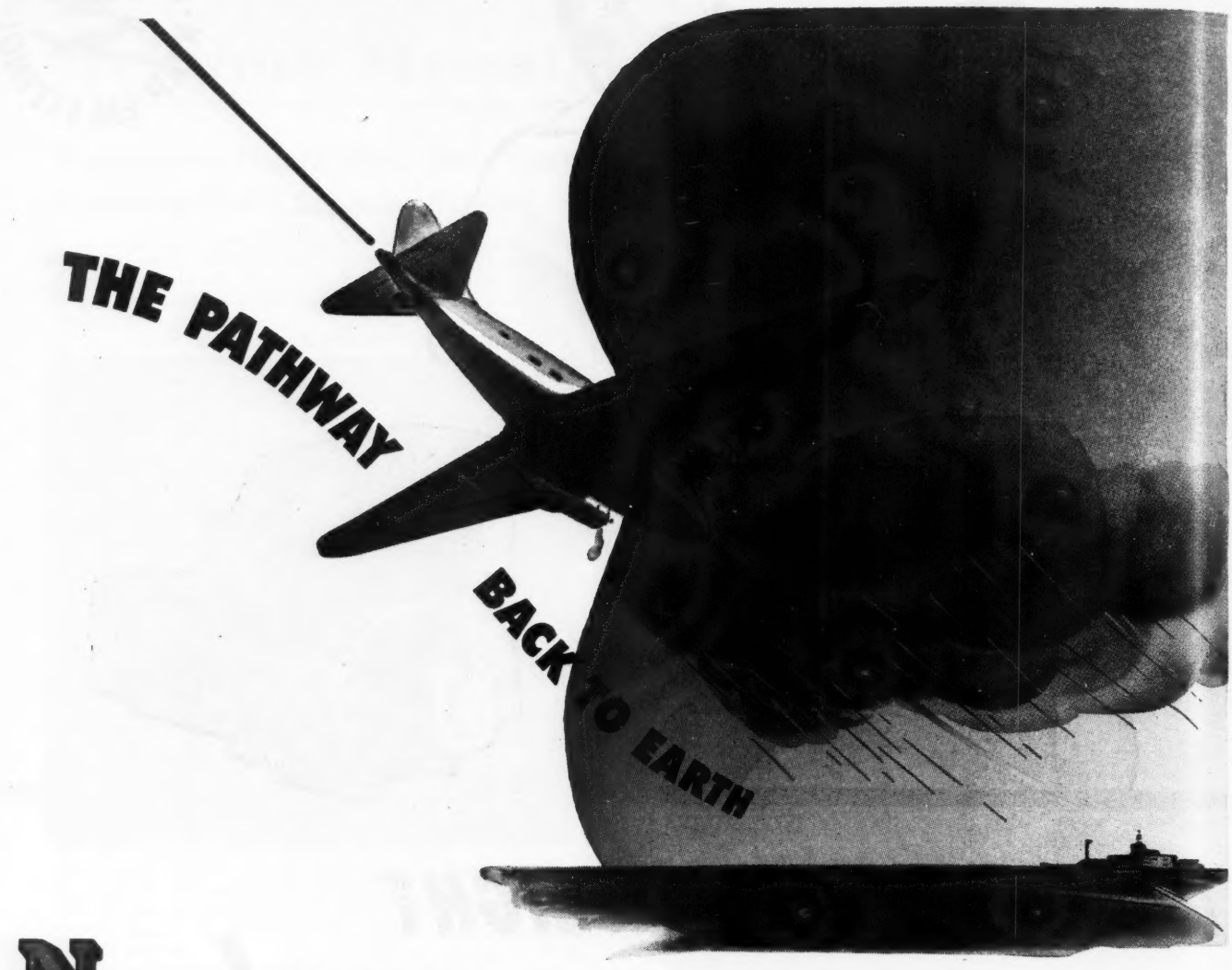
MAKE THEM MORE AND MORE AUTOMATIC



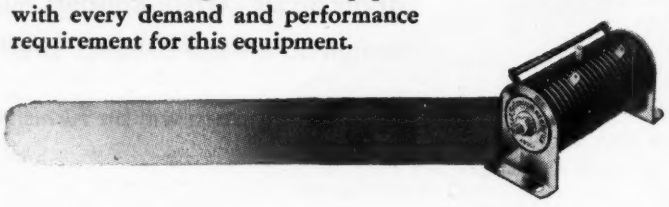
No worry about courses, positions or landings need disturb the calm of the pilots who today handle the giant craft of the sky. They fly with confidence, sure in the knowledge that the science of radio will keep them safe on their courses and bring them safely to their airport homes.

Federal has been a chief contributor to safety in the air. Its developments in radio aids to navigation have marked some of the most important steps in aviation progress. Particularly has Federal anticipated the needs for the Ultra High Frequency Radio Range and Instrument Landing System and the trends in their design and operation.

This equipment, into which Federal has put its broad experience and top technical abilities, in cooperation with the Civil Aeronautics Administration, not only meets the strictest government specifications, but is the most advanced of its kind. Radio ranges and instrument landing systems, manufactured by Federal, mark the principal air routes of the nation and control the landing at many of the country's leading airports.

Today, Federal is the outstanding producer of radio aids to navigation for the war effort. Looking forward to the tremendous after-the-war growth of aviation, it is geared to keep pace with every demand and performance requirement for this equipment.

Federal, which pioneered the development of the Selenium Rectifier, manufactures specially designed rectifier equipment for aircraft. Rugged, light weight, trouble-free, this equipment withstands momentary overloads, high altitudes and extreme climatic conditions.



Federal Telephone and Radio Corporation

AERIAL NAVIGATION PRODUCTS DIVISION — AN IT&T ASSOCIATE — Newark, N. J.

accurate aiming of bomb sights and guns, longer life for the plane, and less nerve-strain on pilots and crew members.

The new mounts decrease the original weight of each B-17 by about 15 lb., or 45 lb. on the basis of extra lifting capacity which is needed for each original pound.

Engine vibration is absorbed by a natural rubber sleeve in the unit, nine of which are supplied for each engine. In addition, a knuckle in each engine mount is of a plastic stated to eliminate any need for oiling or greasing. Mounts are interchangeable with those used heretofore. No design change was necessary in the suspension structure.

Manufacturers' Reports

Three big-league airplane producers tell you something about their volume of output:

Consolidated - Vultee Board Chairman Tom Girdler said his company delivered over 12 percent by number of the '43 output—which was 85,946 planes. In terms of pounds, C-V delivered 16 percent. The chairman said the Nashville Vultee plant took high place in efficiency in production of single-engine bombers.

Douglas at the same time, was stated to have produced 96,446,000 lb. of combat planes valued at one billion dollars, cut man-hours per unit more than 50 percent, lowered costs an over-all 22 percent, and paid $50,000,000 in taxes.

Boeing recently delivered its 9,000th *Kaydet* primary trainer, the PT-17. This is more airplanes than both Army and Navy owned when the war started in Europe. Production of all training planes, and tactical planes (grasshopper or liaison) has been reduced, and only a trickle of *Kaydets*, plus parts necessary to maintain those in service, are coming out now.

Further Notes

Hamilton standard propellers, the four-bladed type, will be fitted to a number of P-47's.

Cherry Rivet, Los Angeles, reports output has increased 500 percent in the past year, and that enlarged production has resulted in a price drop of 1/3 of that a year ago.

Buick reports 24,626 P. & W. engines were shipped from Flint and Melrose plants in 1943, totalling 29,500,000 hp. Peak employment totalled 45,000, as against 17,000 in 1941.

Formica Insulation Co. has just completed film depicting manufacture of firm's plastic products. It plans making this film available to colleges, universities, and manufacturers.

Studebaker announces its 1943 Wright *Cyclone* engine output was 350 percent greater than in 1942. Volume for last year was 29,016 units.

★ FOR THE RECORD ★

Malabar Machine Co., Los Angeles, will now be represented throughout the world, except U. S. and Canada, by Curtiss-Wright Export Sales Div.

Bendix Aviation Corp., Pacific div., has opened N. Y. C. office at 60 E. 42nd St. with R. C. Crabbe and J. C. Moody in charge.

Shell Oil Co. has opened new cracking plant at Wood River, Ill., thus quadrupling its present 100-octane gasoline output.

Becker Aircraft Sales Co., Pittsburgh, has opened N. Y. C. branch at 1775 Broadway, with warehouse at 225 E. 38th St.

O'Connor Aircraft Co. has started sales and service organization in former AA hangar at Albany Municipal Airport.

Mengel Co., Louisville, and U. S. Plywood Corp., N. Y., have made a joint marketing agreement for plywood and plywood products.

Allied Control Co. announces opening shortly of a new plant in Chicago.

General Aircraft Corp., Astoria, N. Y. C. has purchased Tennessee Aircraft Co., Nashville.

Joseph T. Ryerson, Inc., has purchased Carnegie, Pa., steel warehouse of Bethlehem Steel Co.

Progressive Welder Co., Detroit, has opened factory branch at 1007 Broxton Ave., Los Angeles (24).

Fairchild Aviation Corp. has changed name to Fairchild Camera & Instrument Corp.

Gray-Mills Co., portable coolant manufacturer has moved to a new plant at 1948-52 Ridge Ave., Evanston, Ill.

Colonial Broach Co., Detroit, has opened district offices at Pittsburgh and Indianapolis.

B. F. Goodrich's Industrial Products Sales div. has acquired national distribution rights for Punch-Lok hose clamp.

Ballard Aircraft's main offices and engineering dept. have been moved to 331 Madison Ave., New York City. Factories are at Elkhart, Ind., and Arthurdale, W. Va.

Genesee Tool Co., Fenton, Mich., has established factory service and district sales offices in Dayton, Cleveland, South Bend, Toledo, Pittsburgh and Cincinnati.

Titeflex Metal Hose Co., Newark, N. J., has changed its name to Titeflex, Inc.

Cardox Corp., Chicago, has elected Dr. Charles A. Getz, its research director, to new position of vice-president in charge of research.

Discontinuance of United Airport Div. and its incorporation into Pratt & Whitney Aircraft is announced by United Aircraft.

Change of corporate name to Pacific Div. of Bendix Aviation Corp. has been effected by Bendix Aviation, Ltd. Operations and personnel will continue the same.

Diesel and engine equipment division has been organized by Adel Precision Products, Burbank, Calif. Its director will be Wing Comdr. J. G. Goodenough.

L & R Mfg. Co. has opened Chicago sales office under supervision of John W. Denniston.

Consulting engineering service specializing in investigations and reports is announced by R. Harland Horton, 1052 Commercial Trust Bldg., Philadelphia 2.

New plant in Long Island City, N. Y., has been occupied by Kurman Electric Co.

PRODUCTION - BATTLE CITATIONS

★ Two Stars ★

GREENFIELD TAP & DIE CORP.
HALLICRAFTERS CO.

★ One Star ★

BORG WARNER (Universal Joint Div. and Rockford Drilling Machine Div.)
CURTISS-WRIGHT CORP., (Propeller Div., N. J. and Pa. plants)

Army-Navy "E"

ALUMINUM CO. OF AMERICA
AMERICAN CHAIN & CABLE CO. (Wilkes Barre, Pa.)
BALDWIN LOCOMOTIVE WORKS
BLACKHAWK MFG. CO.
BRILL CORP.
BRYANT ELECTRIC CO.
CHARLES H. BESLY & CO.
CARLTON LAMP CO.
CONTINENTAL CAN CO.
E. I. DUPONT DE NEMOURS CO.
FIREPROOFING CO. (Youngstown, Ohio)
L. F. GRAMMES & SONS
GREAT LAKES STEEL CORP.
HOUDAILLE-HERSHEY CO.
LOGANSPORT MACHINE CO.
GLENN L. MARTIN-NEBRASKA
NACHMAN MOTOR CO.
OSBORN MFG. CO.
PITTSBURGH PIPING & EQUIPMENT CO.
PRATT & WHITNEY AIRCRAFT Div., UAC, (Southington plant)
PRESTO-O-LITE CO.
REVERE COPPER & BRASS CO.
ROCKBESTOS PRODUCTS CORP.
SHELL OIL CO., INC. (Martinez, Calif.)
SQUARE D CO. (Milwaukee)
WOLLENSAK OPTICAL CO.

9,000TH BOEING PRIMARY TRAINER

Undersecretary of War Patterson (right) and Lt. Gen. Knudesen (left) watch Gen. Ray G. Harris of AAF accepting 9,000 PT-17 primary trainer "Kaydet" from J. E. Schaefer, Boeing Vice President and General Manager.

Improved Supercharger "Ups" P-38 Performance

War Dept. announces that installation of an improved supercharger, boosting the horsepower of its twin Allison engines 30 percent to over 1,500 each, enables the lockheed P-38 *Lightning* to increase its rate of climb at all altitudes. Reported is a radical climb increase over 30,000 ft., good performance at "well in excess" of 40,000-ft. heights, increase in straightaway speed at high levels; and better than 300-mph. flight on a single engine.

Addition of tankage gives it increased range for deep penetration as a fighter escort, and fitting of new aileron boosters, combined with the old combat flap, enables the pilot to outmaneuver many single-engined fighters, the Army says. Unit power controls and automatic temperature controls simplify the pilot's operational job.

Coast "Quits" Down; "Pools" Save Man-Hours

Los Angeles (AVIATION Bureau)—Creation of "labor pools" to salvage otherwise lost man-hours, and a steadily declining "quit rate" are reported by the West Coast airframe plants through their AWPC. One plant, Douglas Santa Monica, reports more than 1,000,000 man-hours salvaged through its labor pool plan, and another, unnamed, reported its severances in December declined from 5.69 percent to 3.77 percent.

In the seven West Coast airframe plants, the October "quit rate" was down to 5.79 percent, or 19.36 percent below September's 7.18 percent. In November severances dropped to 5.36 percent, which was 7.4 percent blow October. December figures, not yet complete, indicated the plant performance quoted was the rule rather than the exception, and another region-wide drop was expected.

During November the Coast plants lost 16,548 workers from all causes, compared to 17,883 the preceding month and a July-August-September average of 22,893. Especially significant, it was believed, was the fact that severances for "personal" reasons dropped from 49.52 percent to 42.14 percent.

The Douglas Santa Monica plant labor pool was set up to salvage man-hours otherwise lost because of material shortages, schedule changes, new specifications, and other such causes which frequently caused temporary idleness in one section of the plant while other sections needed workers. Under the pool plan workers are sent to the pool which "loans" them to departments short of their skills.

A similar pool plan, adopted at North American, differs in two respects. Here, the worker can request transfer to the pool, and if no other department needs the particular experience and skill of workers in the pool, they are given productive work in a special department set up for the purpose.

Stall Warners Devised

CAA has developed two new low-cost stall-warning instruments, soon to be available commercially. A third type, now under development by CAA, will warn pilots of impending stalls even when the wings are iced (the first two do not function under icing conditions).

With the two devices now perfected, the pilot is warned of approaching stall by the sounding of a horn and flashing of a light when the plane reaches a certain angle and the flow of air is reversed. Scheme of the third device is a warning triggered by changes in the characteristics of the airflow over the top surface of the wing. All three units are easily installed in existing aircraft, are light in weight, and self-monitoring.

New Tradeway to Mexico

Opening of new trade channels in Mexico is announced by Herman Yaras, head of Yaras & Co., Los Angeles importing and exporting firm, on completion in Mexico City of arrangements with Mexargo, that country's large trading company with wide Latin-American distributing facilities. Yaras believes that "Mexico wants and needs American products quickly" and that this is a propitious time for American manufacturers to consummate exporting plans.

L-262 Revoked

WPB's Limitation Order L-262, controlling transactions in second-hand ground training craft (like the Link trainer) and single-engined light aircraft of 500 hp. or less, was revoked Jan. 15. OPA ceiling prices governing used-plane sales are the only remaining government controls now applicable to these craft. Owners or part-owners are merely required to record used-plane sales by filing copies of all bills-of-sale and turning over certificates of registration endorsed by the purchaser to CAA.

★ ASSEMBLY LINES ★

"Salt-mixture controlled oxidation process" applied by Aviation Corp's Republic Aircraft Products Div. to small engine parts along six-tank production line gives them harder surface and marked anti-friction and anti-rust qualities.

Pellets of Tenite plastic made by Tennessee Eastman Corp. are being used to blast carbon from piston walls and piston ring grooves. The particles, 1/16 in. and smaller, are blown through a hose attached to a sand-blasting unit under 80 to 100 lb. air pressure controlled by foot pedal.

What Westinghouse calls the world's fastest industrial motor —1,000 revolutions per second —has been built by one of its research engineers, R. M. Baker. It is suggested for direct attachment to grinders used to put high finish on engine parts.

Elimination of duplicate drawings is reported by Consolidated Vultee's Fort Worth plant through use of X-ray apparatus which reproduces lines scribed on cold rolled steel by a special process involving luminous lacquer.

For checking hollow steel propeller blades. American Propeller Corp., Toledo, has installed a 400,000 v. X-ray unit which makes three shots of each of three blades in the time formerly needed to make one negative. Automatic conveyor moves blades through a lead-lined studio while four women are preparing the next set.

Wood and glue construction is estimated to have saved over 5,000,000 tons of metal during the past year.

Nash-Kelvinator is using a specially devised electronic apparatus for testing propeller governors. It measures time to 1/10,000th of a second and presents its findings, accurate to 1 rpm., on dials.

"Heatronic molding" employs artificial fever radio waves to heat plastic so that it flows freely into dies, states Bakelite Corp. . . . "Cyclewelding" uses a special cement which forms joints stronger than rivets or welds when heat and pressure are applied to the materials. Details of the process are being offered gratis for the duration to war material manufacturers by Chrysler Corp.

Plywood sheets can be stuck together with radio power from pistol-like device developed by RCA. Resistance of layers of the wood to the current generates heat which melts glue previously spread between them. Use of temporary staples is thus eliminated.

Conveyor belt 40 ft. long that moves castings through an X-ray machine and thus eliminates the necessity of evacuating operators from the vicinity during exposures, is announced by Westinghouse, its developer, as making 17,000 inspections possible in 24 hr.

West Coast AWPC is making available Ryan scheme of reducing minor mistakes. Inspectors make out discrepancy reports which are sent to a quality control manager. His department immediately traces and corrects the difficulty.

Electrically induced anodic coating for magnesium alloys developed by Convair is claimed to save 6/7 weight of prime and lacquer coats formerly used. New coating is described as tight and very resistant to abrasion and electric current, with abrasion resistance over 50 times that of anodized duraluminum.

Educational Dept. of Interstate Aircraft has produced a number of 16 mm. films for instruction in woodworking, aircraft repairs, steel tube structures, dot-doping, and other subjects.

PUT STRESS ON SAFETY

Accenting the axiom that safety is a prime requisite for postwar personal planes, Aeronca engineers put scale model craft through speed-and-drag paces on testing device in U. of Detroit aeronautical department. Left to right: Aeronca's Research Director Ed Burn, Chief Engineer Bill Hall, and Consulting Engineer Peter Altman.

Thumbs Down on H-K?

Pressure was being brought by Administration agencies to stop work on three wooden flying boats, reported to gross more than 400,000 lb. each, under construction by Henry J. Kaiser and Howard Hughes. WPB, which agreed with Kaiser-Hughes and others who wanted to start the project when aluminum was short, now is advised by its aircraft experts and by AAF and Navy officials that continuation of the work is of doubtful merit.

Objections are that the flying boats are gathering more weight than expected, that they are using scarce plywood and manpower, that engines for them will be hard to get and that they probably cannot be used in this war. Mr. Kaiser, however, promises to test fly one of them in 1944, and many aircraft men feel that the work should be finished for experimental value.

Plane Ceilings

Release of more personal planes, hitherto employed in training, is indicated by request of CAA that price ceilings be set on those with single engines of less than 500 hp. OPA has now set ceilings.

AN INTRICATE DIE-PRESSED ALUMINUM FORGING

by REVERE

Weight: 1¾ lbs.; length: 9"; extreme width: 6"

The intricate die-pressed housing pictured above is really quite a job. It is typical of other difficult die-pressed aluminum forgings that Revere can supply in a wide variety of shapes and weights with a wide range of applications. The aviation industry alone has eagerly availed itself of these strong, close-grained, intricate die-pressed aluminum forgings and will attest their economy and utility. Revere forgings are also available in copper, various copper-base alloys and magnesium.

Revere will be glad to give you technical advice—*without obligation*—on any special problems that you may have in the field of die-pressed forgings. Write Executive Offices.

FREE! A 54 page manual, "Revere Copper and Copper Alloys—Technical Information for Product Designers," with 106 graphs relating to physical and metallographic properties under varying conditions; also, a new, easy-to-read chemical and physical properties chart, with pertinent illustrated information on Revere manufactured forms and welding technique. A complimentary copy sent you upon request. Address: Executive Offices.

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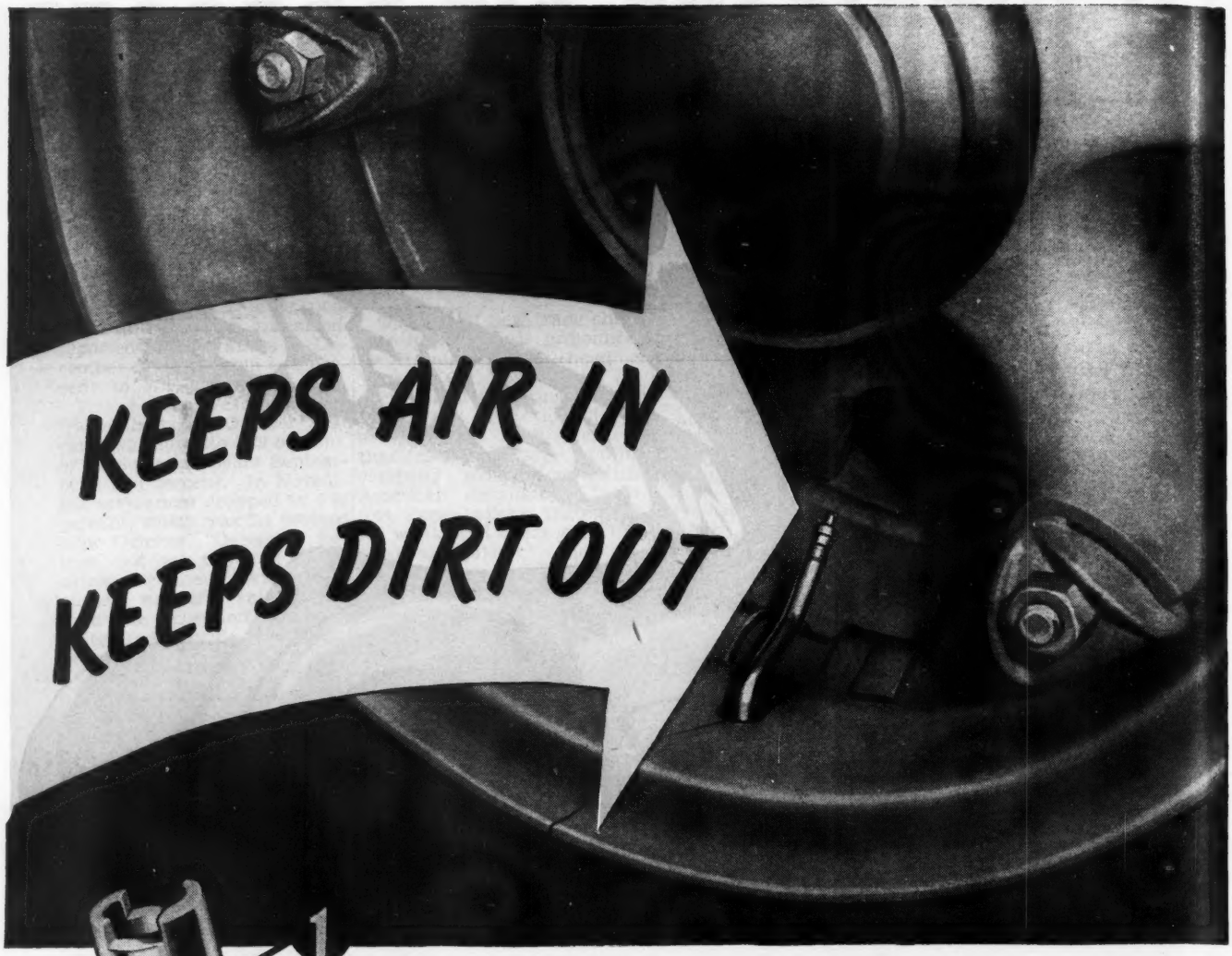
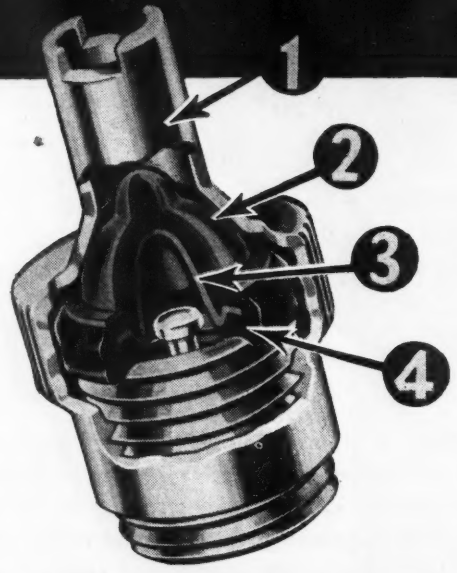
Founded by Paul Revere in 1801

Executive Offices: 230 Park Ave., New York 17, N. Y.





LOSS of air pressure in truck tires causes excessive tire wear, and increases the cost of fleet operation. To offset any air loss through the valve make sure that every truck in your fleet is equipped with Schrader Tire Valve Caps.

Schrader Valve Caps screwed down finger-tight are designed to *keep air pressure in,* and to keep dirt out. Their unusual construction offers four features* that team up to maintain a positive seal—under all operating conditions.

In addition to saving the rubber in your present tires, Schrader Tire Valve Caps cut maintenance costs. Save yourself time and money—do these two things:

First: See that Sealing Valve Caps are on every tire valve.

Second: Whenever you check tire pressures, be certain to *replace* valve caps!

Observance of these two simple rules requires investment of a few pennies and a few seconds per tire but means dollars in additional tire mileage, and prevent hours of roadside delay.

***SCHRADER FEATURES**

1. Valve Cap body or shell.
2. Brass Swivel Plate allows Cap Shell to turn independently of rubber washer as Cap is applied. This assures proper seating of washer and prevents distortion.
3. Brass Dome-Shaped Plate provides an **indestructible** chamber for safe clearance of valve core pin.
4. Molded Rubber Washer seals valve mouth when Cap is screwed on firmly by hand; while rubber between brass plates 2 and 3 provides spring action to **maintain** positive seal.

Schrader
REG U.S. PAT. OFF.
CONTROLS THE AIR

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SCHRADER TIRE VALVE CAPS

Guaranteed Air-Tight Up to 250 Pounds Pressure

A: SCHRADER'S SON, *Division of Scovill Manufacturing Company, Incorporated,* BROOKLYN, NEW YORK

Lea Bill Still Complicates Legislative Moves; Action Seen Delayed by Further Debates

Washington (AVIATION Bureau)—Civil air legislation is now in a state of uncertainty equal to that which prevailed for two or three years prior to enactment of the civil aeronautics law of 1938. This is not surprising because aviation affects more people and larger interests now than then—both here and in the world around.

The legislative battle centers around the Lea Bill, introduced over a year ago by Rep. Clarence Lea, chairman of the House Interstate & Foreign Commerce Committee. This bill, HR 3420, would create a Civil Aeronautics Commission, combining CAB and CAA, and move it out of the Commerce Dept.; provide independent accident investigation; revise federal and state regulation of civil aviation; provide for airport regulation and development; give the government new port zoning powers; call for a number of studies and reports by Congress; and in general take care of "accumulated obsolescences."

As time passes, the various aviation groups find more provisions they don't like in the bill. Though amendment of the controversial Section 408 (which deals with conditions under which surface carriers may be certified to operate in the air) has been segregated in a separate bill, HR 3421, the steamship and railroad people insist on settling the matter by amendment to HR 3420.

Two leading groups supporting the Lea Bill are the ATA and CAA. Opposition piles up against them. Passing over the ramifications of congressional committee delays, civil air legislation seems due for long debate in House, Senate, and final conference committee. Main issues are between state and federal control of aviation, and between surface and air carriers.

Six Lines to Put DC-4's In Postwar Service

Douglas four-engine DC-4 transport planes, called C-54 by the Army and R-5-D by the Navy, will be used in the postwar period by American Airlines, Eastern, Pan American, Panagra, United, and Western.

Sixty-one DC-4's were on order by four airlines when the war started—AA, 30; UAL, 20; EAL, 8; and PAA, 3. The Army took over the orders and no DC-4's were delivered for airline operation, although some have gone into contract operations and an undisclosed number to Army and Navy ATC and NATS respectively.

It is unofficially explained that the original orders now have no legal standing, but that the Douglas company recognizes the prior rights of those who placed them.

About four years ago the first DC-4 was given trial by United Airlines. It was well received. But on recommendation of several operators, Douglas changed the design, reducing the wing area, cutting dimensions here and there, but increasing load capacity. The orders were placed on this second design. The original was sold to the Japanese government, and the little men crashed it.

U. S. Has 49 Entry Fields

Today, the U. S. has 49 airports of entry—37 permanent and 12 temporary—according to Treasury Dept. designations. In pointing out these figures, Thomas E. Lyons, executive secretary, Foreign-Trade Zones Board, D. of C., remarks the fact that some of these ports lie at a considerable distance inland from the sea or national border, bearing out the air-ocean aspect of future sky trade, which is not limited by ocean or land demarcations.

Lyons cites Wichita, Chicago, Dallas, Minneapolis, Miami, New York, and Fairbanks, Alaska, as centers which are specifically "emerging" as sky trade bases. He said it is now possible "to think of all Europe, Africa, North and South America, and parts of Asia as being within 24 flying hours of the U. S."

Airports Increase

CAA airport program during 1943 increased the number of U. S. landing fields suitable for transport aircraft from 660 to 940. The number at the end of 1940, when the CAA program was launched, was 94. In all categories, the U. S. now has about 3,000 airports, compared with approximately 2,500 two years ago.

Record '43 Air Express

For second consecutive year, air express shipments on domestic lines set records, according to Railway Express Agency preliminary figures. Shipments for 1943, 16th year of carriage, amounted to 14,000 tons, 29 percent over 1942's 10,850 tons. Average package, of which there were approximately 1,500,000, weighed just under 20 lb. and was carried about 1,000 mi. The carriers' load amounted to about 45 tons a day.

NRPB Postwar View

In the first few years after the war, airline business may expand to 5 to 8 times that of 1942 and will need 550 to 840 planes of Curtiss *Commando* capacity, NRPB estimates. The board believes that in-flight pickups and regular passenger flights will provide sufficiency to handle all mail.

OWI Lets Public In On Transport Facts

Washington (AVIATION Bureau)—OWI's recent report was the first official roundup of the wartime operations of 21 airlines, including 14 companies flying foreign routes. Many of the facts covered were already known to airmen, but operators are pleased to have the public informed.

Naval Air Transport Service acknowledges itself indebted to the lines, particularly its two contractors, Pan American and American Export.

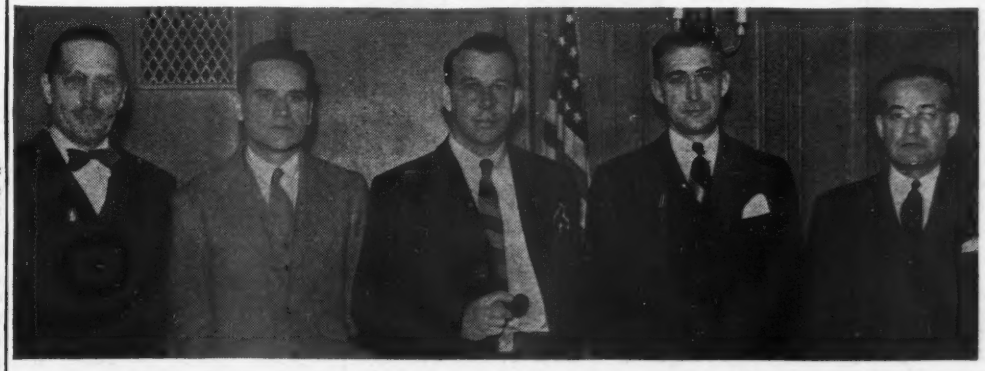
Maj. Gen. Harold L. George, chief of the Army Air Transport Command, says his organization could hardly have functioned without the lines.

It is revealed that ten of them rushed troops and supplies to the Aleutians, aiding in ejecting the Japs. Fourteen lines are flying internationally for the Army. Four of their routes are mentioned: North Atlantic; Africa-India-China; South Pacific; Alaska-Aleutians.

Greatly increased domestic service by the carriers which lost about half of their equipment, is possible, the report says, because of 80 to 100 percent load factors, economy because of fewer types of planes, use of them 10-12 hr. per day in the air instead of 8½, and fewer stops.

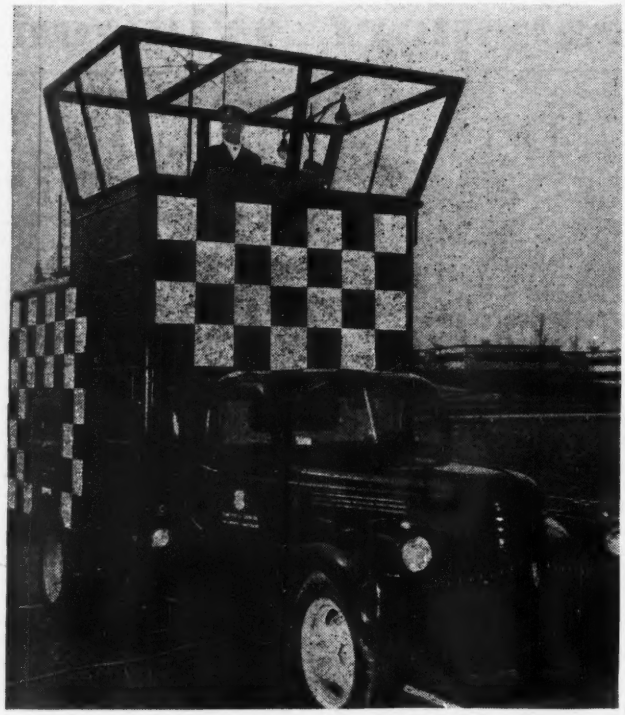
Expansions, Applications

Air express shipments are being accepted from 40 U. S. cities and 23 Mexican states by American Airlines which estimates that this expansion provides coordinated service to 23,000 American localities. To Mexico, shipments will be



NEW AIR TRAFFIC CONFERENCE OFFICERS

Elected to positions in the Air Traffic Conference of America at recent Kansas City meeting were (left to right) President, Charles E. Beard, traffic vice-president, Braniff; First Vice-President, Nelson B. Fry, United; Second Vice-President, Thomas Wolfe, Western Air Lines; and (far right) Executive Secretary, M. E. Redfern. Second from right is Vincent P. Conroy of TWA, retiring 1943 president.



READY FOR TRAFFIC AT PULL OF THE BRAKE

New mobile airport traffic control tower, developed by CAA's Air Traffic Control Div. in collaboration with Army's Engineering & Signals Div., can be put into action in a matter of minutes and will perform all functions of a stationary tower. Operated by two men, unit's power plant will produce 5,000 v. for operation of six intermediate-frequency and four ultra-high frequency receivers, also both a low-frequency and an ultra-high frequency transmitter. (CAA photo.)

routed through Monterrey or Mexico City and thence by most expeditious air or ground transportation.

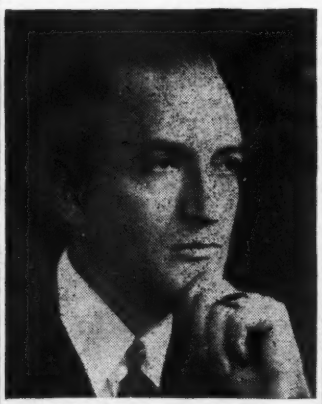
Consolidation of several local lines into one integrated service for the territory is announced by Alaska Airlines. W. N. Cuddy is president of the new system serving 63 cities.

AEA Joins "Free Policy" Group; Burke New V-P

American Export Airlines recently announced its formal alliance with the Airlines Committee for United States Air Policy. The group of airlines which declared for "free and open competition—worldwide" last July 15, now number 17. Their policy is opposed to that of Pan American Airways and United Air Lines, which contend that American flag foreign air services should be jointly owned by the air operators.

Export announced that it is against either private or government monopoly in air transport; that it agrees with CAB's policy of reciprocal rights between countries in world air transport; and that it expects the amount of competition in the foreign field will be limited to the number of routes determined by CAB.

Coincident with the announcement, Export revealed that Tom Burke, State Dept. aviation expert, had been appointed its vice-president in charge of foreign relations.



THOMAS BURKE

He is now vice-president in charge of international relations for American Export Airlines. Recently chief of the U. S. State Dept.'s International Communications Div., he directed work of ousting Axis from South American aviation and radio, took primary part in establishing radio links between U. S., New Zealand, and Australia, and was leader in diplomatic liaison promoting development of our military world air routes.

Propose Weight "Ups" For DC-3 and C-60

War emergency operation has demonstrated that air transport equipment can do more, in many cases, than initial cautious regulations specified. One instance is the proposed increase in takeoff weight of the DC-3 commercial transport plane by 1,000 lb. and its landing weight by 800 lb. Another proposal would increase both landing and takeoff weight of the Lockheed *Lodestar* C-60 transport by 1,000 lb.

Following hearings on these suggestions, CAB points out that these proposals apply specifically to Douglas and Lockheed transport aircraft equipped with Wright G-202 or Pratt & Whitney S1C3G engines.

★ CROSS COUNTRY ★

Title to Treasure Island in San Francisco Bay, site of '39-'40 World Fair and now a Navy air and embarkation base, will be exchanged by the city of San Francisco for $10,000,000 worth of federal improvements at Mills Field, municipal airport. Agreement includes postwar acquisition by the city of the Mills Field $3,500,000 seaplane base, now 70 percent completed.

Some 45 colleges and universities are getting scholarship grants from UAL for use at their summer sessions in furthering improved aviation instruction.

PCA has opened a transitional flight school for naval transport pilots at Woodrum Field, Roanoke, Va.

UAL recently completed its 50,000th transcontinental flight. Marking the record were two men who flew portions of the company's first coast-to-coast run in '27—E. P. Lott, now superintendent of design, buildings, and airports, and W. D. "Bill" Williams, superintendent of eastern flight operations.

Boeing's Chief Engineer Edward C. Wells, predicts 16-hr. coast-to-coast service by major lines at fares 40 percent under present rates right after the war. Fares of $60 in 100-passenger planes may be expected two years later, he believes.

Westinghouse engineers have built a new airport runway contact light to withstand loads of 150,000 and 200,000 lb. from landing wheels. Their framework employs bridge design.

Braniff Airways is resuming service to Waco, Tex.

Delta Air Lines is seeking authority to fly a new direct route between New Orleans and Cleveland.

Southern Airways has filed application for air routes covering nearly 100 communities in eight southern states. Passenger, mail, and express services are planned over 15 routes.

Franchise to Northeast Airlines to serve Boston, Lawrence, Worcester, New Bedford, Hartford, Providence, New York, and Newark has been recommended by CAB Examiner Thomas Wren.

Sky-Roads, an exhibition of modern maps, has been shown by CAA in Commerce Building, Washington, to orient laymen with the air age.

Civilian flyers need no longer get CAA clearance for flights outside of defense areas.

Three best postwar business possibilities, an engineer concluded from a survey, are housing, air transport, and trade with South America. Accordingly, he has a scheme which he feels can't miss—to fly prefabricated houses to South America.

. . . And We Quote

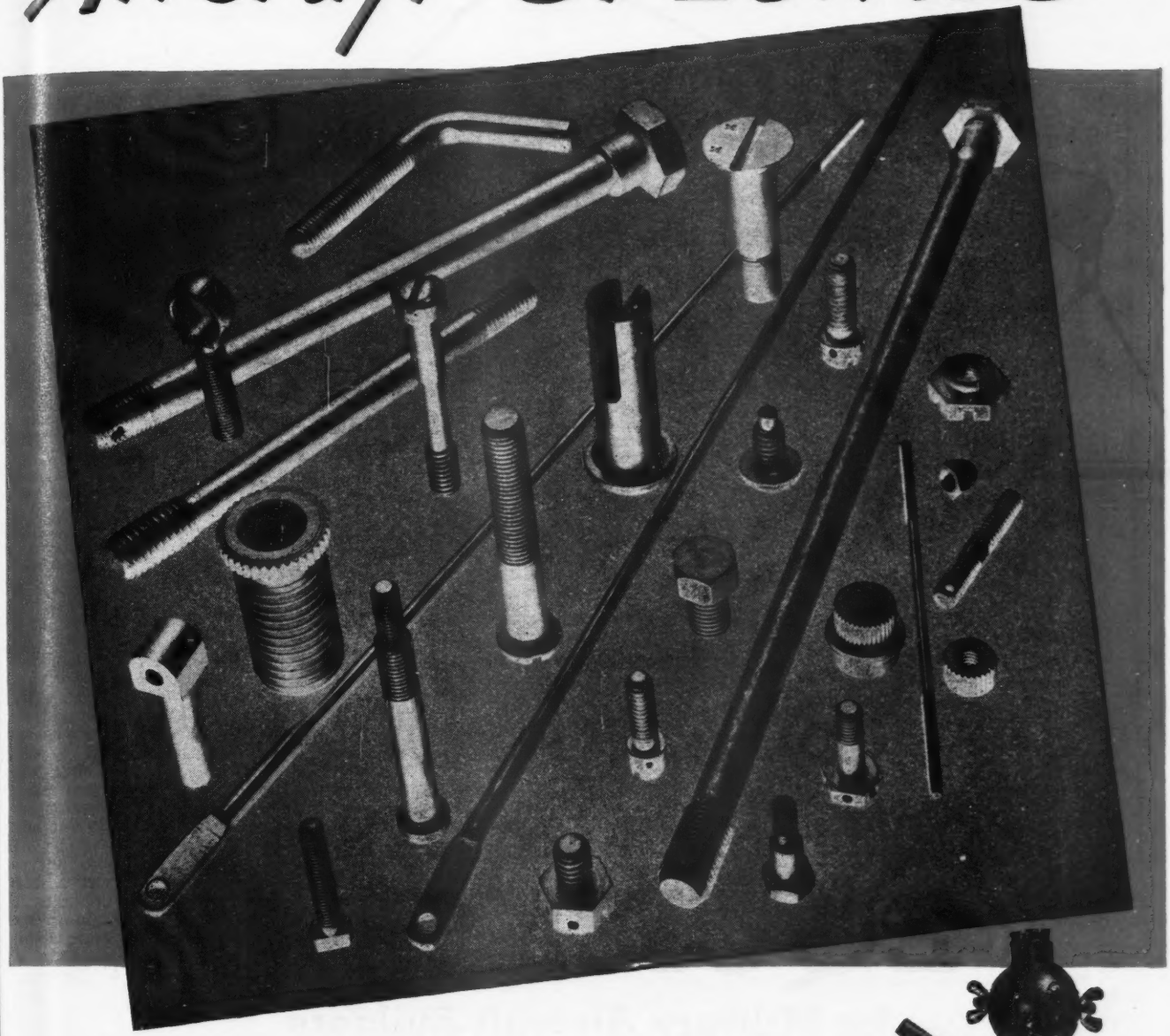
"We need [in the coming peace] little airfields that are privately owned by individuals or groups to accommodate their own aerial vehicles. We need small airfields sponsored by communities, by counties, and by states so that those who cannot afford their own fields still can have the advantage of proper ground facilities, as they have adequate roads and highways. We need airfields near ball parks, beaches, golf courses, race tracks, amusement parks, favorite country eating places, fishing and hunting haunts, etc. —in fact, wherever people gather. And especially do we need them near people's homes and places of business so that they need to walk only short distances from their front doors to their aircraft. Every community needs the smaller airfields, whether or not a large airport is in order also. Actually, the smaller airfields come first. . . .The mere existence of many airfields will be a major contribution to the maintenance of a strong and vigorous aircraft industry in the post-war world." — *John M. Hagen,* Airport Project Chairman, Personal Aircraft Committee, Aeronautical Chamber of Commerce.

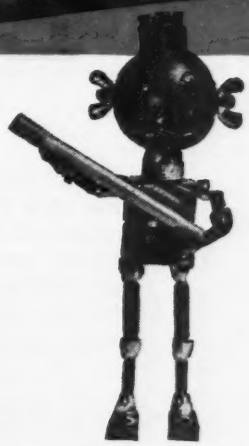
"No Sensible man would attempt to predict more than 10 yrs. ahead what might happen in the rapidly changing aviation business. . . . We need airports with zippers in them [airports affording expansion when the need arises]."—*Charles I. Stanton,* Administrator, CAA.

"Unless the cities of America face the challenge of providing adequate airport facilities, not even the most conservative estimates of air growth can possibly be attained. . . . We feel that the airlines, with their huge maintenance base facilities, their know-how, their experience in aircraft upkeep, their weather forecasting and dispatch procedures, should provide concrete and reasonable access for the private flyer, especially during the period after the war when these facilities will not be readily available in many places. . . . You are going to have hundreds and thousands of persons who will want facilities for private flying. These facilities will mean business and progress.—*C. Bedell Monro,* President, Pennsylvania-Central Airlines.

"If we are to keep our great industrial machine operating, we must find foreign markets or dismantle a large part of that capacity. Air transportation offers the greatest promise for the fulfillment of this national need."—*Oswald Ryan,* Acting Chairman, CAB.

Aircraft "SPECIALS"





NATIONAL SCREW HAS EXCEPTIONAL FACILITIES FOR PRODUCING SPECIAL AIRCRAFT FASTENERS

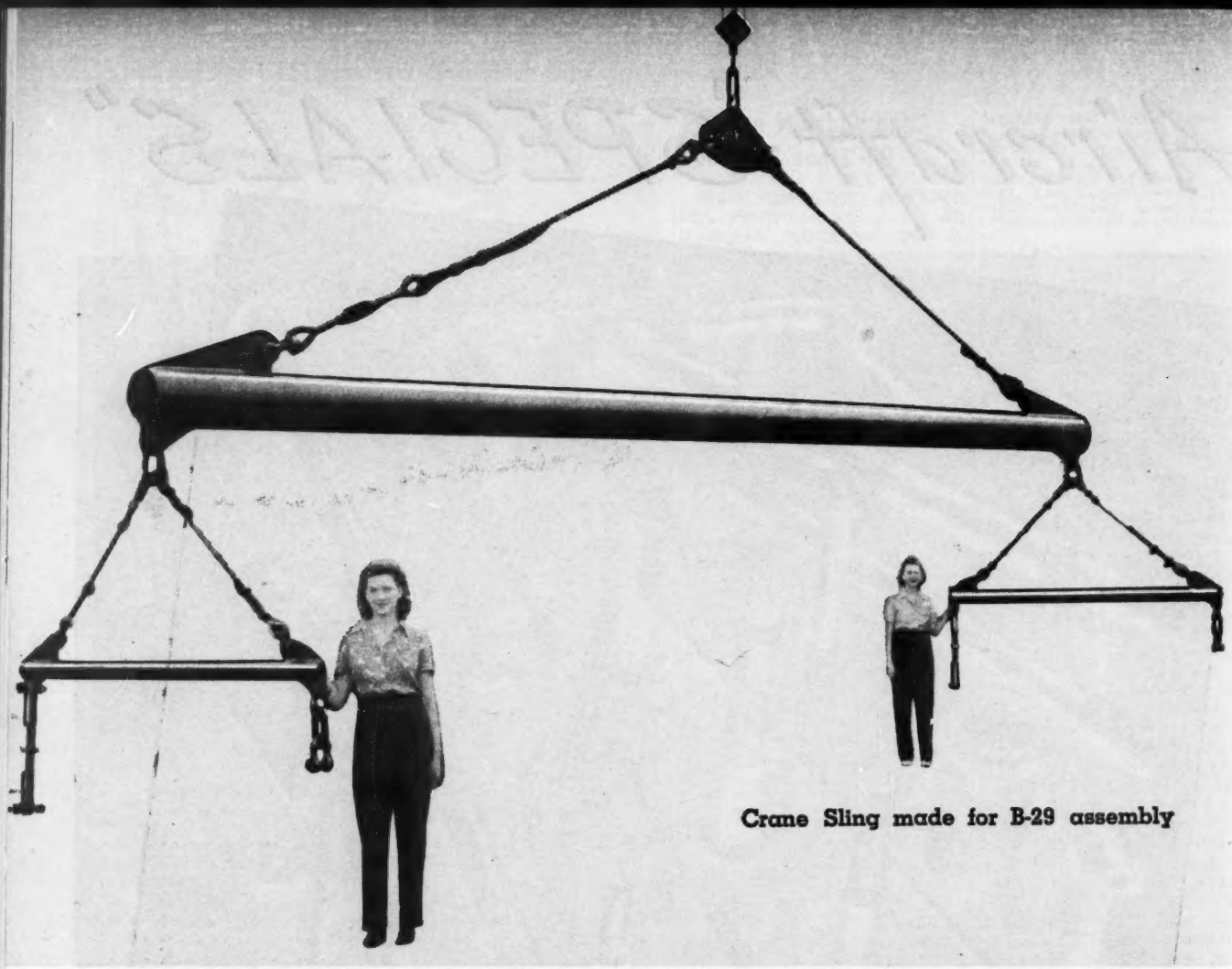
In addition to the regular AN and ANS standard fasteners, "National" aircraft products include many special parts designed by airplane and parts manufacturers.

A few of these "specials" are pictured above, such as carburetor studs, motor mounting bolts, swaged rods, drilled head bolts, stainless eyebolts, brake adjustment screws, carburetor screws, gyroscope struts, dome nuts, shear bolts, and a number of others.

"National's" engineering and metallurgical experience, modern manufacturing and heat-treating facilities, and closely integrated production layout—including our own wire mill—equip us to give our customers exceptional service.

National
HEADED AND THREADED PRODUCTS

THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.



Crane Sling made for B-29 assembly

Time and Labor-Saving
EQUIPMENT
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Tell of Nazi Glider-Bomb And New Rocket Plane

One recent report from overseas gives a more specific picture of the Nazi rocket-powered glider-bomb, while another story tells of the German development of a rocket-propelled fighter.

The first report, of greatest credence since it came from London, confirms earlier word that the Germans are using twin-engine bombers fitted with a special launching apparatus for firing radio-controlled rocket-propelled glider-bombs for attacks on shipping. First assaults by these bombs were not successful, but it was noted that the winged projectiles approached their targets under complete control. Initially, they glided toward the Allied ships, then when directly over them they dived vertically at the objectives. Wingspan of the projectiles is given as 15 ft., which is more in keeping with the glide-and-dive description than the 25-ft. span first reported.

The other report (from Sweden, and therefore to be taken with a grain of salt) tells of the Nazis' use of a new type fighter with true rocket propulsion, rather than the jet type recently publicized. The new craft is said to climb 4½ mi. in 2 min. According to the story, this compares with a normal climb taking 15 min., but this latter time would only apply to out-dated interceptors, there now being a number of aircraft which can reach 4½ mi. in 7 or 8 min.

★INTERNATIONAL BRIEFS★

From training grounds at Corpus Christi, Tex., Mexico is ready to launch its first air unit of the war. After inspection by Air Chief Gen. Gustav Salinas Carranza, it will depart for the Pacific.

Scale model of an eight-engine transport designed by British Minister of Aircraft Production F. G. Miles has already been flown. Planned for easy conversion for war or peace use, the plane, it is said, "will have a range of 3,450 mi. and will carry 50 passengers and crew of five at a 350 mph, cruising speed against a 50-mi. headwind." Basic design can be applied to a medium-range model. The larger plane will be all metal with Roll Royce engines arranged in pairs in wings spanning 150 ft.; length is 110 ft.; cargo capacity on maximum distance will be 16,430 lb.

Dennis H. Hanover has resigned as traffic head of British Overseas Airways to accept appointment as air adviser to Britain's four main railway companies.

More details on Avro York, transport version of Lancaster bomber. This plane, it's now stated, can carry a load of 10 tons over distances up to 1,250 mi. or 56 passengers with baggage, mail, and express. With smaller loads the range increases to more than 3,000 mi., which can be covered at speeds averaging 275 mph.

British officials were red-faced recently when two strictly hush-hush aircraft were included in an air show and two 'teen-agers were found making sketches of them to add to their collections.

Group Capt. F. Whittle, jet propulsion developer, was recently elected a Fellow of the Royal Aeronautical Society at a meeting of the Society's Council. This election, directly by the council, is a special distinction reserved for those who have done signal service in the advancement of aviation.

Another British shipping line viewing air traffic possibilities is Port Line, Ltd., which has received a court Okay to change its bylaws to allow operation of air services in conjunction with shipping. The court, however, did not authorized an independent air service.

The Germans are using a modification of the Ju-38 (identified as the Ju-188), for hit-run raids on Britain. Powered by two BMW radials of 1,500 hp., loads at short ranges are said to be around 4 tons.

Curacao is again being included in PAA's West Indian schedules, after a lapse of some 10 yr.

RAF has received its first service craft with tricycle landing gear—the Armstrong Whitworth Albemarle, (taken off the secret list in January). A wood and steel plane, it will be used, according to reports, in invasion glider towing.

China's "C-47 Road"

Most remarkable cargo flight of recent months, according to word now released, was the trip of 35 C-47 transports (Army DC-3's) from America to an Indian base to start the "Burma Road of the Air," new airborne-supply line to China.

The ocean was crossed between Natal, Brazil, and Africa, with the planes taking off from Natal with more than 1,C00 gal. of gas each (in itself representing 3¼ tons), supplies for two years for the maintenance of the aircraft, a crew of four and, in some cases, up to five passengers. Each plane weighed from a high 33,000 to 35,500 lb. at takeoff.

On the India-China run, these planes often gross 29,000 lb. (Army gross weight) carrying anything from dynamite to food, and total airborne tonnage has now exceeded the amount once carried by truck on the Burma road.

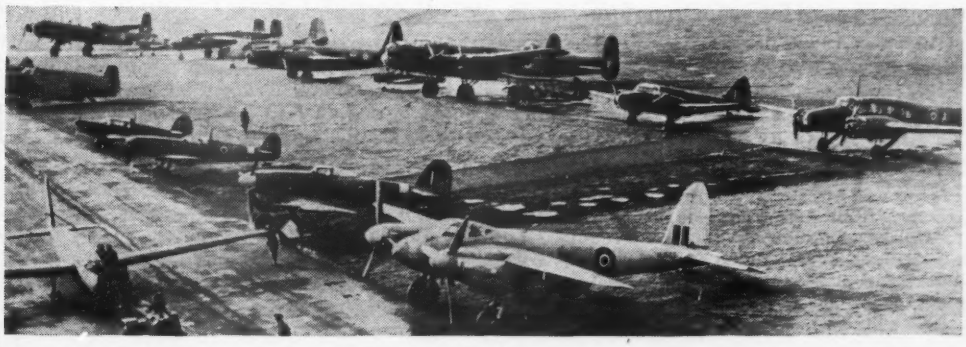
On Schedule by "Vista"

A start has been made in Washington on some kind of established policy in regard to postwar air transport. At this writing, a senate subcommittee is calling a number of witnesses, said to include PAA's Trippe, AEA's Slater, and the State Dept.'s Berle. Main considerations are anticipated to be Panam's "chosen instrument" policy and American Export's claims to an equal share in future ocean air transport.

Informal discussions have already taken place between United Nations' leaders on this all important subject, as was borne out by Lord Beaverbrook's recent statement announcing the "innocent air passage" principle, which both the United States and Britain are supporting. Certain other facts have come out, including the CAB stand that foreign concessions should be handled by the proper government authorities, also a proposed general ban on all commercial flying and aircraft production by the defeated Axis nations. Services as needed would be established by United Nations' companies, probably controlled by a world board.

Increasing interest of American airlines and financial houses in Central American and especially Mexican airlines is expected to bring about a marked expansion of air traffic in that region. Mexico's government is vitally interested in the development of fast transportation. The "good neighbor policy" is seen assisting the lines to obtain the necessary equipment from the United States.

London's *Daily Mail* is behind a demand for an airport the size of New York's Idlewild project to serve Greater London. Among airports now being studied for such a development is Gatwick, once before considered a "model" terminal. Meantime, U. P. Hildreth, director general of Civil Aviation, foresees Croydon declining to a mere way-station after the war.



18 DIFFERENT TYPES (COUNT 'EM)

Research and experimental flying is emphasized at Britain's Empire Central School, where more than a score different types of aircraft are usually ready on the line. Front row (l. to r.): "Avenger" (with folded wings), "Proctor," "Spitfire," "Typhoon," and "Mosquito." In distance behind "Avenger" are "Master III" and "Hurricane." Back row (l. to r.): "Stirling," "Master," "Mitchell," "Havoc," "Wellington," "Magister," "Lancaster," "Tiger Moth," "Oxford," and "Anson." Being towed in left foreground, "Hotspur" glider rounds out this roster of noted aircraft. (British Combine pohto.)

Tonight...

AIR CIRCUS for "ANXIOUS AXIS"

Between landing invasions and winning of airfields, it becomes a matter of fewer and fewer days. The technique of re-establishing a captured airfield or the installation of a new one has been worked down to a matter of hours.

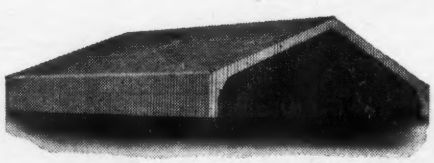
Our hats are off to the Engineering Corps of our armed forces for their foresight in early recognition of the need for engineering into complete airfield equipment the mobility of a circus. Sometimes the tasks assigned to us by the Engineers seemed impossible of accomplishment—for instance, a Combat Hangar mobile enough to keep up with battle fronts that jumped a sea or an ocean overnight.

Long since, that "impossible" assignment has become routine, mass production in Butler factories, along with steel mats which hook together and in a few hours make an airfield runway, steel buildings for machine shops, warehouses and living quarters, bolted-together storage tanks for aviation gasoline, as well as truck and transport tanks for refueling warplanes.

Tomorrow...

STEEL HANGARS for EVERY AIRPORT NEED

As they produce for war, Butler engineers plan for peace. Already, the Butler Combat Hangar has been redesigned—is ready to take its place alongside the Butler hinged-arch design hangar and Butler private plane hangars. Together they will comprise the outstanding line of all-steel fire-safe, economical hangars readily adaptable to every peacetime airport need. At the left is illustrated the Butler Combat Hangar with its wartime canvas envelope replaced with permanent covering of galvanized-to-last steel, panel corrugated to give it strength four times that of ordinary continuous corrugation.



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Aviation Finance

Bell Aircraft Corp. has paid off a $60,000,000 V loan and arranged a new VT loan of $10,000,000. Important Army contracts have been converted to a basis of government advances, and as a result of the new financing its fighter plane contracts will be appreciably simplified, according to the management. The new loan has contract termination clauses not available in the earlier loan.

North American Aviation has postponed until a later date its annual meeting usually held Feb. 23 owing to accounting problems. Pres. J. H. Kindelberger stated that because of renegotiation proceedings financial statements that would accurately reflect the results of 1943 operations could not be furnished prior to the usual annual meeting date.

National Aviation Corp. 1943 report discloses the sale of 25,000 shares of Curtiss-Wright common stock, 5,000 shares of Curtiss-Wright A stock, 5,300 shares of Boeing, 7,100 shares of Grumman, 20,000 shares of Continental Aviation & Engineering, 3,000 of Parker Appliance, 2,600 of Lockheed, 1,500 of United Aircraft common, and 6,730 shares of Bell. Sales of airline stocks were more moderate.

Atlas Corp., which figured prominently several years ago in connection with a move to recapitalize Curtiss-Wright Corp., now holds a controlling interest of 90,000 shares in Northeast Airlines. The Boston & Maine and Maine Central railroads have disposed of 100,000 shares of Northeast, thereby reducing their holdings from a 30 percent interest to 10 percent.

Air Investors reports its net assets, as of Dec. 31, 1943, and based on market value of securities owned, were $1,052,783, equal after allowing for preference stock at liquidating value to $3.10 a common share against $1,023,349 or $2.35 a share the previous year.

Western Air Lines is understood to have an offer from an eastern bank to finance equipment expansion up to $5,000,000 if proposed extensions of its present routes are granted by the CAB.

Consolidated Vultee Aircraft Corp. has issued an adjusted financial statement for the year ended Nov. 30, 1942, showing net profit of $12,551,011 or $8.86 a common share after figuring final renegotiation of contracts for that year. A $5,700,000 reserve for postwar readjustments was set aside from 1942 profits.

Security transactions by aviation officials last November included the purchase of 7,800 shares of Republic Aircraft by John J. Daly, 1,000 shares of Colonial Airlines by Francis Hartley, Jr., and the sale of 1,000 shares of Brewster Aeronautical by Russell Van Horn.

Aerovias Braniff, S. A., a company controlled by Pres. T. E. Braniff of Braniff Airways, has been granted a Mexican permit covering 2,643 mi. of air routes in Mexico. After the initial organization and development period it is expected that ownership of the line will be transferred to Braniff Airways. The transfer will be subject to CAB approval.

Laister-Kauffmann Aircraft Corp. of St. Louis has acquired the Bowlus Sailplanes Co. of Los Angeles through an exchange of stock. Holders of the latter firm will also receive profit sharing certificates and options to purchase additional shares. Both concerns manufacture gliders.

General Aircraft Corp. of Long Island has acquired the Tennessee Aircraft Co. of Nashville, Tenn., maker of aluminum alloy fabrications. General Aircraft is one of the principal producers of gliders for the AAF.

Beech Aircraft Corp. more than doubled production in the fiscal year ended Sept. 30, 1943, with sales amounting to $97,043,000 and net income totalling $4,035,965 or $10.08 a share against $1,802,980 or $4.50 a share in the preceding year. The company is filling $98,000,000 in wing contracts for a combat craft besides making complete planes, Pres. Walter Beech recently told stockholders. He predicted that the company will be completely engaged in filling government contracts this year and added he hoped for government provision to permit the company to set aside adequate postwar reconversion reserves. Meanwhile, a new subsidiary, Material Distributors, Inc., has been set up to dispose of excess materials. Unfilled orders approximated $200,000,000 at the recent year-end.

Cessna Aircraft Co. reports sales of $70,729,401 in the fiscal year ending Sept. 1943, while profits were $2,208,414 or $6.31 a share against $738,202 or $2.11 in the 1942 year. At the year-end, Cessna was using $10,000,000 of its $15,000,000 V-loan credit, according to Pres. Dwane L. Wallace.

Solar Aircraft reports net earnings of $514,974 or $1.57 a share for the six months ended Oct. 31, 1943 against $323,796 or 97c a share in the like 1942 period. The 1943 profits are still subject to renegotiation procedure.

Chandler Evans Corp. of South Meriden, Conn., has been acquired by Niles-Bement-Pond Co. through an exchange of stock.

By RAYMOND L. HOADLEY

National Aviation issues significant report . . . Congress action on renegotiation disappoints . . . Postwar refunds may aid in cutbacks . . . Wartime financial record of the airlines.

SINCE National Aviation Corp. is the largest aircraft investment company, its annual report is always of interest to Wall Street and aircraft stockholders. And this year, Vice-Pres. Frederick F. Robinson and Executive Committee Chairman Otis Glazebrook had plenty to report: National's holdings in aircraft manufacturing stocks were reduced to 35.5 percent of total assets last year, having come down from 51.0 percent in 1942, while airline holdings were cut to 24.2 percent from 28.3 percent in 1942. Holdings of other stocks such as General Electric Co. and General Motors Corp. came up from 0.7 percent to 17.7 percent.

At the same time, the report expressed faith in future developments, for instance in the jet propulsion plane, as attested by its holdings of 22,770 shares of Bell Aircraft. It also said that while some new interests might be expected in aviation after the war, the companies which had shown leadership during the present crisis will definitely survive.

Despite the fight put up by aircraft industry spokesmen and a few aviation-minded Congressmen to obtain more favorable treatment under renegotiation of contracts, about the only substantial changes finally made in the new tax law were to terminate contract renegotiation by the end of 1944 (or six months later if the President so decreed) and to provide for appeals to the U. S. Tax Court in cases where industry and the government do not mutually agree on the latter's renegotiation findings. All hopes for a better break on renegotiation now must center on the newly-created Baruch committee's study of the postwar reserves question.

Outside of special legislation to provide termination financing, it appears unlikely that Congress will even attempt to write a corporation tax measure before or during the fall political campaign. However, there seems to be a good prospect that sometime before the war is over Congress may get around to making corporation tax refunds available.

Both Treasury and Congressional experts are understood to be receptive to the idea of pre-armistice tax refunds, recognizing that production cutbacks may give rise to the need for working capital before the war is over. One plan calls for making the fund automatically available when war contracts are reduced 50 percent. Another proposal, and one more likely to get serious consideration, would require war contractors to prove their need to the Treasury before they would be permitted to cash in on their refunds. If legislation along these lines is forthcoming, it would be of immense aid to the aircraft industry.

The nation's airlines increased their revenues by $7,000,000 in the twelve months ended last June, with total revenues topping $114,000,000 while operating expenses declined about $10,500,000 to $82,500,000. This was done, as a CAB report points out, despite the airlines' loss of nearly half their planes to the government after Pearl Harbor.

The air carriers increased their earned surplus from $13,000,000 to $27,000,000 and reduced their long term debt from $2,250,000 to less than $750,000. At the same time 28,000 passengers had to be refused plane space and more than 1,000,000 lb. of mail and a like quantity of express had to be left aground.

In the current June-30 fiscal year, revenues will again soar, due in no small part to the dozen or more planes returned to the lines by the government. On the other hand, the long term debt will be at a new high record due to the decision of several lines to raise capital now for postwar needs.

"TRUCK HORSE" OF TOMORROW...HERE TODAY

Here's a new cargo transport you'll see and hear plenty of — Fairchild's C-82! Built of metal and designed to operate in and out of small fields, the C-82 has a range of 3500 miles on her twin radial engines. Further details of her design and performance are closely guarded military secrets — but it's *no secret* that in engineering the C-82 for today's war needs, Fairchild also designed a plane that will fit smoothly into the air commerce of peace.

We at Kenyon are particularly proud to have been in at the birth of the C-82, supplying the precision-built wind tunnel models which first gave indication of the design and performance of "tomorrow's cargo carrier." We feel that this service was symbolic of our relationship to the aircraft industry, and of our anticipated contributions to airplane manufacturers in the future.

Precision is our business; even in wartime, we gladly take the responsibility of saying "When you need precision parts or instruments, you can rely on Kenyon to supply them, in quantity and on time— *even if they have never been made before!*"

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Aviation People

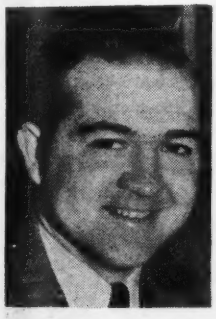
WILLIAM H. McAVOY, chief test pilot of the NACA, was selected by the Institute of Aeronautical Sciences to receive the Octave Chanute Award for 1943 for his "continuous service in the flight testing of experimental airplanes under hazardous conditions imposed in aeronautical research."

GORDON C. SLEEPER is appointed director of public relations for Republic Aviation Corp. and will be responsible for public relations, advertising, publicity, and sales research. He has been with Republic since 1942, when he joined the executive staff as asst. to the president. (Harold Haliday Costain photo.)

GEN. HENRY H. ARNOLD, commanding general of the U. S. Army Air Forces, received the Robert F. Collier Trophy for the most outstanding contribution to American aviation during 1942 at ceremonies climaxing celebration of the 40th anniversary of the first heavier-than-air flight at KittyHawk. (USAAF photo.)

EARL E. LOTHROP has been appointed head of the new research and statistics department of the Aeronautical Chamber of Commerce. Formerly he was assistant to Sperry Gyroscope's general sales manager, and before that manager of market research for Westinghouse. (Underwood & Underwood photo.)

CAPT. GILL ROBB WILSON resigned as president of the National Aeronautic Association and as editor of "National Aeronautics" to become aviation editor of the New York "Herald Tribune." He has been president of the NAA for four terms, and is New Jersey's aviation director. (Harris & Ewing photo.)



R. W. DARROW, former public and internal relations manager of the Curtis-Wright Columbus warplane plant, transfers to Buffalo as assistant director of public and internal relations for the entire airplane division. **W. A. MAHARRY** (right), associated with the Columbus plant since the spring of 1943, succeeds him as public and internal relations manager. Before joining C-W, Maharry was executive secretary of the Zanesville, Ohio, chamber of commerce.

DEAN C. SMITH has joined the executive staff of Fairchild Engine & Airplane Corp. to be in charge of development activities. For the past several years he has been Curtiss-Wright's director of transport. (Tommy Weber photo.)

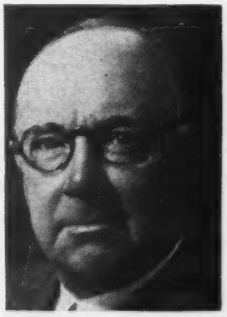
HUGH FENWICK, former assistant to the executive vice-president of Consolidated Vultee, has joined Curtiss-Wright Corp. Fenwick recently returned to the United States after a three-month tour of foreign air bases.

HUGH W. MORRISON, associated with British West Indian Airways, has been named assistant to the president of TACA Airways, new holding company for WIA, Aerovias Brazil, and Transportes Aeroes Centro Americanos.

CARL W. ELKINS returns to Taylorcraft as asst. to Pres. James C. Hart. Until a year ago, Elkins was general sales manager, when he left to spend a year as pilot for EAL. In his new post his major concern will be government contracts.

HOWARD S. WELCH, former v.-p. and g. m. of Bendix Aviation Export, has been appointed export sales manager for the Sperry Gyroscope Co. During World War I he was an officer on Brig. Gen. "Billy" Mitchell's staff.

J. E. DUFFIELD, JR., has been appointed advertising manager to handle public relations for Republic Aviation Corp. He will also continue as supervisor of the company's motion picture development. (Bachrach photo.)



CLAYTON R. BURT, formerly president and general manager of Niles-Bement-Pond, was promoted to chairman of the board, and **CHARLES W. DEEDS** (right) was elected president and general manager. Burt will continue to spend full time at the plant which has been under his executive management since 1924. Deeds retains active management of his own former company, Chandler-Evans Corp., which was recently acquired by Niles-Bement-Pond. (Burt photo by Blank & Stoller.)

Recent Books

• THE AVIATION ANNUAL OF 1944, edited by Reginald M. Cleveland and Frederick P. Graham under supervision of Aviation Research Associates. Doubleday, Doran & Co., New York. 224 pages, index, illustrations, $3.50.

This is the debut of a new annual, first of a series of aviation publications projected by Aviation Research Associates. It cogently summarizes recent progress in various branches of aviation — Army and Navy combat techniques, training, manufacturing, research, transport, and CAP. Forewords to the authors' accounts of events in these fields during the past year have been provided by such men as Gen. Arnold, Charles I. Stanton, Glenn Martin, and Col. Edgar S. Gorrell. Entire section on research is by Dr. Hugh L. Dryden, of the National Bureau of Standards. Bibliography and directory of organizations and manufacturers are appended.

• METAL FORMING BY FLEXIBLE TOOLS, by Chris J. Frey and Stanley S. Kogut. Pitman Publishing Corp., New York. 193 pages, illustrations, index, $3.

By flexible tools, the authors mean those types, chiefly presses and hammers, which are economically and easily adaptable to short-run production requirements. Emphasizing the use of rubber in shaping aluminums and steels, they analyze the uses of press equipment, the power brake, and the rubber die as well as engineering factors in forming, flanging, spring-back of rubber, blanking, die manufacture, and hammer operation. "Any sheet metal item not manufactured in really high production numbers," they conclude, "can be considered a flexible-tool possibility."

• THE GRIM REAPERS, by Stanley Johnston. E. P. Dutton & Co., New York. 221 pages, illustrations, $2.75.

This time Correspondent Johnston, author of **Queen of the Flat-Tops**, considers the story of a carrier fighter squadron in the South Pacific.

• TRAIL BLAZING IN THE SKIES, by Shafto Dene. 78 pages, illustrations. Goodyear Tire & Rubber Co., Akron, Ohio.

The story of Goodyear Tire & Rubber Co's. production and design contributions to aviation—**Corsairs**, blimps, barrage balloons, and airframe parts and components. This is, says Board Chairman P. W. Litchfield, "a comprehensive account of the company's progress in aeronautics down to the present. It seeks to exemplify how free enterprise under the American system employs its own resources to develop skilled engineers and to encourage far-seeing exploration and expansion of new services for the benefit of mankind."

• A.S.T.M. STANDARDS ON PLASTICS. American Society for Testing Materials, Philadelphia. 431 pages, $2.

Eighty-five definitions, tests, and specifications, the latter covering 18 types of molding, sheet, tube, and rod materials. Moreover, 25 tests approved in 1943 are included, along with four standards on non-rigid plastics.

• TRANSPORTATION: WAR AND POSTWAR, Annals of The American Academy of Political and Social Science, Nov., 1943. 258 pages, $2 to non-members.

To this symposium, Lewis C. Sorrell, director of research of Air Transport Assn., has contributed an essay, Air Transport Industries in Wartime. After sketching air carrier development since 1926, he points out (1) That because of postwar ground competition, "airline engineering and operating staffs, together with aircraft and engine builders, must capitalize every item of saving that can be realized through improved plane design and engine performance, fuel consumption, diminished maintenance cost, and smaller administrative overhead"; (2) that the debate over multiple or single foreign operators "is a part of the more general economic problem of determining the degree and type of competition that ought to be maintained as a minimum while seeking to lessen the grosser wastes of uncontrolled competition"; (3) that "with one dominant operating company in the foreign field and four in the domestic, and with the domestic air traffic partitioned among a dozen smaller lines, some air people perceive the possible re-creation in air transport of the weak-and-strong-line problem that has long existed in the railroad field"; (4) that in view of expansion "the adequacy [of the Civil Aeronautics Act of 1938] for the postwar air age is questioned." Following Sorrell's article is a brief survey of the Air Transport Command by its commanding general, Maj. Gen. Harold L. George.

• REPORT OF THE COMMANDING GENERAL OF THE ARMY AIR FORCES TO THE SECRETARY OF WAR. Office of Public Relations. War Dept., Washington. 54 pages, charts, paper-bound. Free.

Of all the documents, books, and pamphlets yet produced on this air war, Gen. Arnold's report is the most inspiring. Succinctly presented, it is all facts, and among them one senses the courage, sweat, deaths of men. The General's resumé of American air power, from near stillbirth to impending invincibility, is a document of great historical importance which particularly accents the development and application of our bombing theory.

Also written (several years ago) by Gen. Arnold with Lieut. Gen. Ira C. Eaker, **This Flying Game** (Funk and Wagnalls, New York. $3) has been revised and enlarged in a new edition. It is a simple account, suitable for schools, of the history and future possibilities of civil and military aviation, pilot training, and employment of aircraft in war.

• THE RAFT BOOK, by Harold Gatty. George Grady Press, New York. 149 pages, accompanying charts, $3.25.

Rule-of-thumb method for downed flyers to find their way to shore. Gatty, avigator of Wiley Post's **Winnie Mae**, bases his principles on methods long used by the Polynesians—observations of sea life, weather, and ways of measuring astronomical angles without instruments. A godly gift to the flyer who remembers to bring the book and a watch set to GCT.

• TIME STUDY ENGINEERING, by William H. Schutt. McGraw-Hill Book Co., New York. 426 pages, illustrations, index, $5.

The president of the Detroit Time Study School presents a comprehensive text analyzing ways to produce more in the same or fewer minutes. Numerous examples of shop practices and machinery.

• AN EDUCATIONAL GUIDE IN AIR TRANSPORTATION, by Ralph E. Hinkel and Leo Baron. Transcontinental & Western Air, Inc., Kansas City, Mo. 140 pages, bibliography, illustrations, index, 75c.

Catalog of jobs in air transport—what backgrounds they require, what they demand and pay, and what advancements they offer. "The task of bringing youth to full consciousness of what the airplane may mean lies with our educators," says TWA Pres. Jack Frye, "and it is to the end of helping them in this vital work that this book has been prepared."

• PRINCIPLES AND PRACTICES OF AVIATION MEDICINE, by Harry G. Armstrong, M. D. Williams & Wilkins Co., Baltimore. 514 pages, illustrations, index, $6.50.

Diligently prepared physician's text on selection, care, disabilities, and treatment of flyers.

• THE SKY'S THE LIMIT! by Charles G. Hall and Rudolph A. Merkle. Funk & Wagnalls Co., New York. 195 pages, illustrations, index, $2.

Frequently exclamatory, this book describes with simple brevity the duties in the chief commercial flying jobs; also given is information on getting the positions. Outlined for would-be employees are job requirements and routines.

• MAN IN THE AIR, by Herbert S. Zim. Harcourt, Brace & Co., New York. 332 pages, illustrations, index, $3.

Non-technical discussion of the effects of flight on the human body. Though the mechanical developments in planes may seem to cry for more human ruggedness, the author believes that "man's problems of air adjustment are capable of solution."

• STANDARD AIRCRAFT WORKER'S MANUAL. Fletcher Aircraft, Burbank, Calif. 158 pages, illustrations, index, $1.50.

Seventh edition of a shopworker's pocket-sized reference covering fundamentals of metal plane construction, properties and treatment of aluminum and steel, standard parts nomenclature, riveting, assembling, and installation, use of tools, and blueprint notations.

• THIS WINGED WORLD: An Anthology of Aviation Fiction, edited by Thomas Collison. Coward McCann, New York. 520 pages, index, $3.50.

Mr. Collison has collected a diverting group of selections ranging from Daedalus and Icarus to some of the short stories which lately appeared in **Esquire, Collier's** and **The Saturday Evening Post.** Among authors represented are Dr. Johnson, Hawthorne, Poe ("The Balloon Hoax"), H. G. Wells ("The War in the Air"), Sinclair Lewis, Conan Doyle, Ben Ray Redman, Leland Jamieson, Paul Gallico, and Guy Gilpatric.

• PLYWOODS: THEIR DEVELOPMENT, MANUFACTURE AND APPLICATION, by Andrew Dick Wood and Thomas Gray Linn. Chemical Publishing Co., Brooklyn, N. Y. 363 pages, appendix, illustrations, $4.

Consumers of plywood will find here straightforward descriptions of the evolution of this material before it reaches them—its sources, physical properties, a detailed discussion of the manufacture of several types, and notes on grading, testing, packing, and storing.

• REFERENCE DATA FOR RADIO ENGINEERS. Federal Telephone and Radio Corp., New York. 200 pages, $1.

For engineers and technicians, this is a handbook of specifications, properties, and characteristics of materials and assemblies. Included are sections on audio and radio design, rectifiers, vacuum tubes, amplifiers, antennas, and mathematical formulas and tables.

• AIRCRAFT IDENTIFICATION, By G. E. Wilson. David McKay Co., Philadelphia. 192 pages, illustrations, index, $1.50.

Drawings and short descriptions, arranged according to visible characteristics, of 27 American, 24 British, 25 German, and 5 Jap war and transport planes. The Russian craft are, inexplicably, omitted, while "the Italian planes have been left out because they have been so ineffective." One page of drawings with several views is devoted to each plane and its tell tale features are lettered on the plates.

• MANUAL FOR AVIATION CADETS, by Lt. John R. Hoyt, USNR. McGraw-Hill Book Co., New York. 199 pages, index, illustrations, $2.50.

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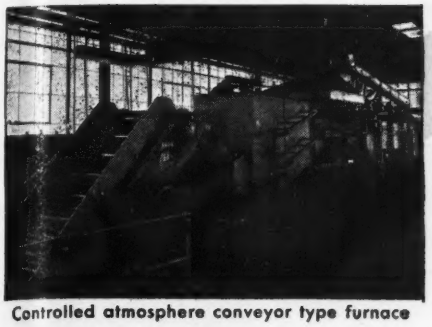

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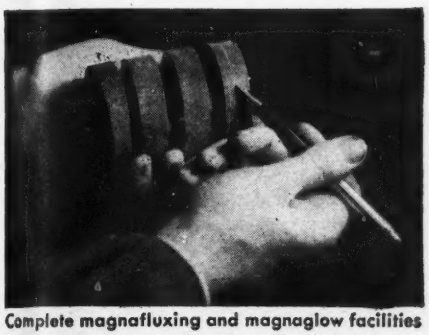

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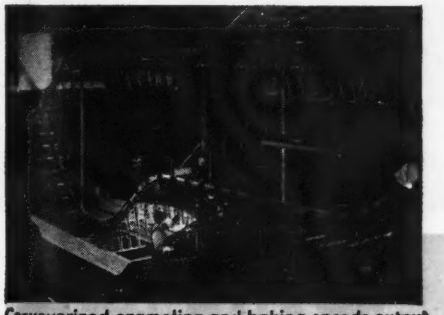

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X-Rays Gage Blades

(*Continued from page* 147)

be applied to similar action on plate of unknown thickness, hence the unknown then becomes a fact. Thus the fundamentals are simple and the accuracy of the X-ray method becomes the direct result of the precision of equipment used and the care with which the process is carried out.

Absorption characteristics of a varying thickness of metal, under a given X-ray technique, have been recognized and utilized frequently. It has been common practice to place a small rectangular piece of metal (ground in steps of various percentages of the thickness of the stock being X-rayed) on the work while producing the X-ray negative (see Fig. 1).

Upon examination of the X-ray negative, the density variations produced by definite percentages of metal variations are discernible. First, the sensitivity of the X-ray technique used is ascertained by determining which of the "steps" are observable. Second, the magnitude of a defect can be roughly estimated by comparing the variations in density, between the defect and the stock, with the density variations of the various "steps" of the reference piece.

This method of determining metal thicknesses is thus followed along the lines of established practice, with the adoption of variations which make the results possible.

Further, it can be said that under a standard set of conditions, the thicker the plate is, the more of the X-rays will be absorved in the plate and the less the X-ray negatives will be affected by the rays passing through the material.

Preliminary shots were made with 1 in. squares of the steel used in propeller manufacture, ground in .020 in. steps over the range of thickness encountered in the propeller design. The range of stock dealt with was approximately .060 to .300. Techniques were set up using the minimum kilovoltage capable of penetrating the stock under consideration in order to produce the maximum change of film density for a given change in thickness of material, since higher kilovoltages tend to flatten out the contrasts. All film densities were determined by means of a standard transmission densitometer.

It appeared desirable to use a film having high contrast, so that with a given thickness change of material X-rayed, a maximum change in density would result. Due to the fact that a densitometer was to be used, a fine-grain film was desirable, so one of the commercial fine-grained high-contrast, non-screen types was selected. A further reason for the use of the non-screen film was the fact that a slight bending of the film in service would be encountered, rendering an intensifying screen unsatisfactory.

A .015 lead backing strip was used immediately behind the film in order to minimize back scatter. And a .005 in. lead filter was used immediately in front of the film in order to eliminate completely the effects of secondary rays and to provide somewhat of an intensifying effect. Quality of the lead immediately adjacent to the film is very important. Lead of filter-screen quality only should be used, since variations in smoothness produce a mottling effect on the negative due to localized emission from the high points of the lead. The latter makes densitometric readings very inaccurate, hence should be avoided if precision work is desired.

Returning to the problem of measuring the blade wall thickness, the set-up used can best be explained by a diagram such as shown in Fig. 2. In order to obtain complete uniformity in film emulsion, 7 x 17 films were cut in two, one piece being used inside of the blade while the other piece was used under the test blocks.

The holder inside the blade was main-

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tained in proper position by locating it with a rubber bladder blown up to hold the film to the contour. The two films were then located directly under the X-ray tube and were simultaneously exposed. A typical technique for steel of approximately .150 thickness was 130 kva., 1350 mas, with a 90 in. focal distance. The long focal distance is not absolutely necessary, but a slight improvement was detected in the accuracy at the extremes of the 17-in. length of film when this technique was used. This, of course, is due to the decreasing of the obliqueness of the X-ray angle.

The dark room technique employed in processing the simultaneously exposed films is of utmost importance. First, ordinary tank development is inadequate for precision results. The thermal variations in such a tank were found to produce as much as .20 D variation in the density of a flashed film from top to bottom, which in some ranges of density would produce an error of .015–.020 in the predicted plate thickness. Pan development is satisfactory though cumbersome. A circulation system was installed in the development tank, proving quite satisfactory and easy to handle.

Simultaneously exposed films were hung in pairs and processed through the development, fixing, and washing tanks. Before drying, the films were rinsed in a solution containing a wetting agent, in order to eliminate any water spotting, which interferes with the densitometer readings.

With the aid of the densitometer, the densities of the various thicknesses of "known" blocks were then determined. A density-thickness curve was plotted such as shown in Fig. 3.

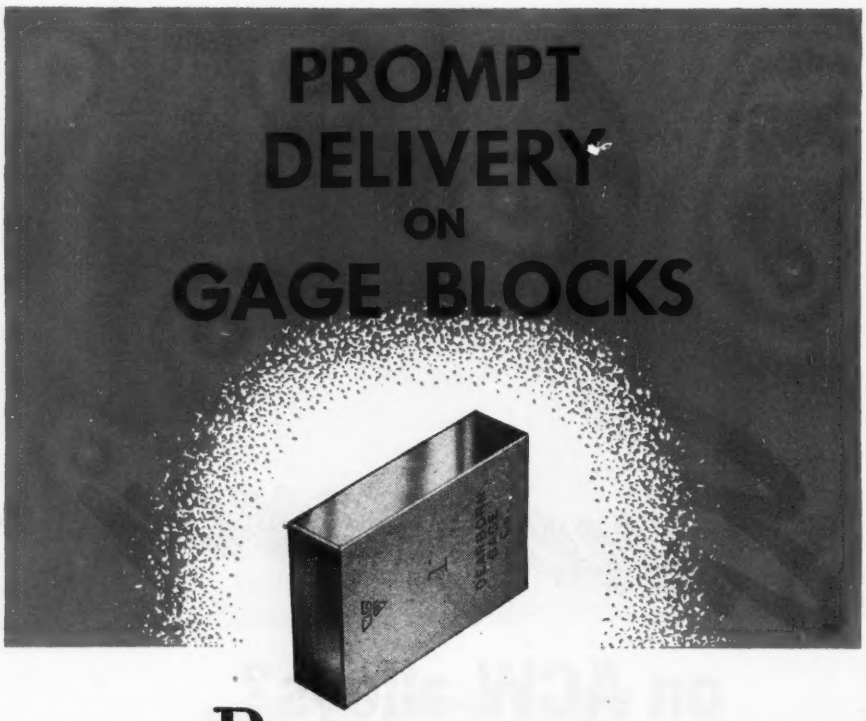
After determining the density of the unknown wall of the blade, the corresponding thickness is ascertained by the use of the density-thickness curve established from the "known" blocks. In Fig. 3 is the entire data used in finding the plate thickness of a scrap blade, sectioned after the tests of plate thickness were made. Accuracy within .003 was achieved in this particular instance. In approximately ten such tests, maximum error was .006 in. In some cases, duplicate shots were taken, and an average was determined which further reduced the error.

A variation in method eliminated the necessity of plotting the densities of "known" blocks and plate thicknesses. Where thicknesses are known to be within narrow ranges, penetrometers with steps of .010 in. can be used, placed in the proper location. Density of the blade film is determined after processing the pair of films. Then density of the penetrometer film is determined and the two "steps" are noted, one more and one less dense than the blade film.

As the density of the blade film has been found to be between those of two known thicknesses of the step penetrometer, a chart, provided for this use, will indicate in thousandths how much should be added or subtracted to determine the blade thickness.

In presenting the above data, reference has been made to propeller blades throughout the discussion. This has been done because the process was developed for this use, and it was felt that the information could be better presented by illustrating with an actual example. However, the methods outlined would be applicable to any measurement of metal thicknesses. Perhaps, at the moment, this statement should be qualified to include ferrous metals only, although, it is the writer's belief that techniques could be developed to operate satisfactorily on non-ferrous metals.

It is hoped that further work along these lines will yield a procedure that is reliable in the hands of inexperienced operators. There are many ramifications and phenomena that occur in this type of work that require further investigation. Control of



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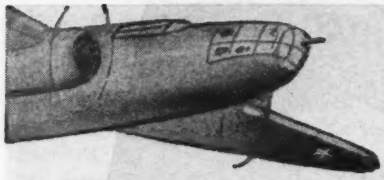

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emulsion and emulsion thickness is one phase that requires additional study.

Occasionally a film is obtained in which the results are erratic. At the moment the discrepancy appears to be attributed to film processing or variations in emulsion thickness. A slight variation, which might be unnoticed on ordinary radiography, could cause considerable error on densitrometric readings. Control of film processing, found to be very critical, requires further study for removing all possible variables. Also, use of direct-reading densitometers appears to be indicated in an effort to remove the human element.

With adequate control and equipment, it has been proved that quite remarkable accuracies are obtainable. With improvements in both, it is the writer's hope that still further precision will result.

SAE Meeting

(*Continued from page* 146)

to meet liquid cooled engine production.

At the evening meeting on the first day, Project Engineer R. B. McIntyre of deHavilland Aircraft of Canada, told about the design and methods of production of Britain's *Mosquito* bomber. It was revealed that this craft is fabricated from ash, spruce and birch phenol bonded plywood with a 3/8-in. balsa wood core. McIntyre told of the many new ideas and improved devices contributing to the plane's excellent flying qualities which have enabled it, on hundreds of missions, to outfly the fastest enemy planes.

Postwar planes that will rival automobiles in price were predicted by William D. Hall, chief engineer of Aeronca Aircraft Corp. He believes that safe, comfortable, private planes selling in the $1,000–$3,000 price range will become popular for pleasure, business, and sport when the war's ending permit their manufacture.

Hall described three postwar types: (1) A low-powered two-place trainer selling for around $1,000 and representing "the minimum amount of aircraft that will satisfactorily fly"; (2) a super-safe two-, four-, or five-place model selling for $1,500 to $3,000; and (3) a two-place low-wing high-powered top-performance job selling for $2,000. He added that these planes would not only be safe and cheap to operate but that, through commodious space and appointments, sound-proofing, vibration-dampening, exhaust-muffling, and air-conditioning, they would be made as comfortable to use as on auto.

J. H. Geisse of Civil Aeronautics Administration, who followed Hall on the program, declared that the postwar private-plane market largely will be determined by how effectively and sensibly industry utilizes manpower and production facilities to improve the over-all prosperity of the country and to prevent destruction or waste of products.

He estimates the immediate postwar civilian market as calling for somewhere between 50,000 and 250,000 planes, meanwhile warning that there is no way to estimate that market exactly. Pertinent factors influencing it: Public interest in flying, aviation education in high schools, reduction in plane costs, increase in roadside landing strip facilities, improvements in plane usefulness and safety, and postwar purchasing power.

Prosperity and wealth, which he said was dependent upon whether postwar employment is directed to producing useful goods or to building pyramids, were held to be vital factors. Geisse likewise reported that more than one-half of those who, in the past, have taken pilot training or purchased private planes, shortly thereafter abandoned flying because of the expense, inaccessibility of airports, high

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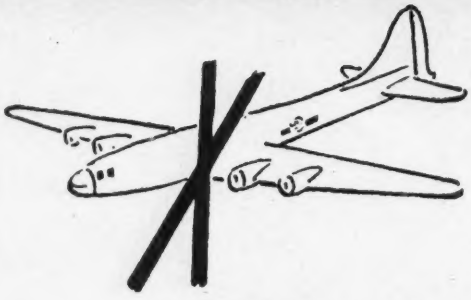

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cost of maintenance, and the planes limited usefulness due to weather.

Postwar plans now being made, Geisse added, contemplate expanding the private plane's utility value by making it roadable to compensate for unaccessible airports and for bad weather. Another possibility for increased use of private planes was seen in the proposed development of "drive-yourself, fly-yourself" systems, whereby automobiles could be rented at convenient city locations, driven to airports, and there exchanged for planes which could be flown to any other airport and turned in.

Mechanical functioning of an airplane engine can be reasonably well established on the test stand, but installation and flight factors effecting its operation in the air have to be determined in the plane itself according to L. C. Miller, of Wright Aeronautical Corp., Paterson, N. J. He explained that an engine in a plane is subjected to accelerations in three dimensions of space and in many different attitudes with relation to the force of gravity.

It is difficult, if not impossible, to simulate altitude, temperature, and pressure variations on the stand and to evaluate these factors on engine performance, he went on adding that successful engine installation involves selection of the plane, weight and balance investigation, aerodynamic and structural calculations, and the details of putting the engine in the available space. Thorough flight testing of engine models by the manufacturer, he concluded, would work for progress in the way of anticipating engine requirements and of eliminating operation faults.

W. Lavern Howland, of Lockheed Aircraft Corp., told the SAE that while there is a plethora of aerodynamic theories and calculations, there is a sad lack of structural flight research data showing the actual magnitude and frequency of the various stresses and loads to which the airplane structures are subjected under flight conditions.

He recommended wider use of wire resistance strain gages for measuring stresses on plane members. He explained that their speed of response is tremendously fast and that they are ideal for studying dynamic strains under conditions of gust and landing stresses. Recent tests, he said, have revealed the possibility of measuring control forces, landing gear loads, gear loads, engine mount stresses, wing flap loads, and wing, tail, and fuselage loads with an accuracy of plus or minus 2½ to 5 percent.

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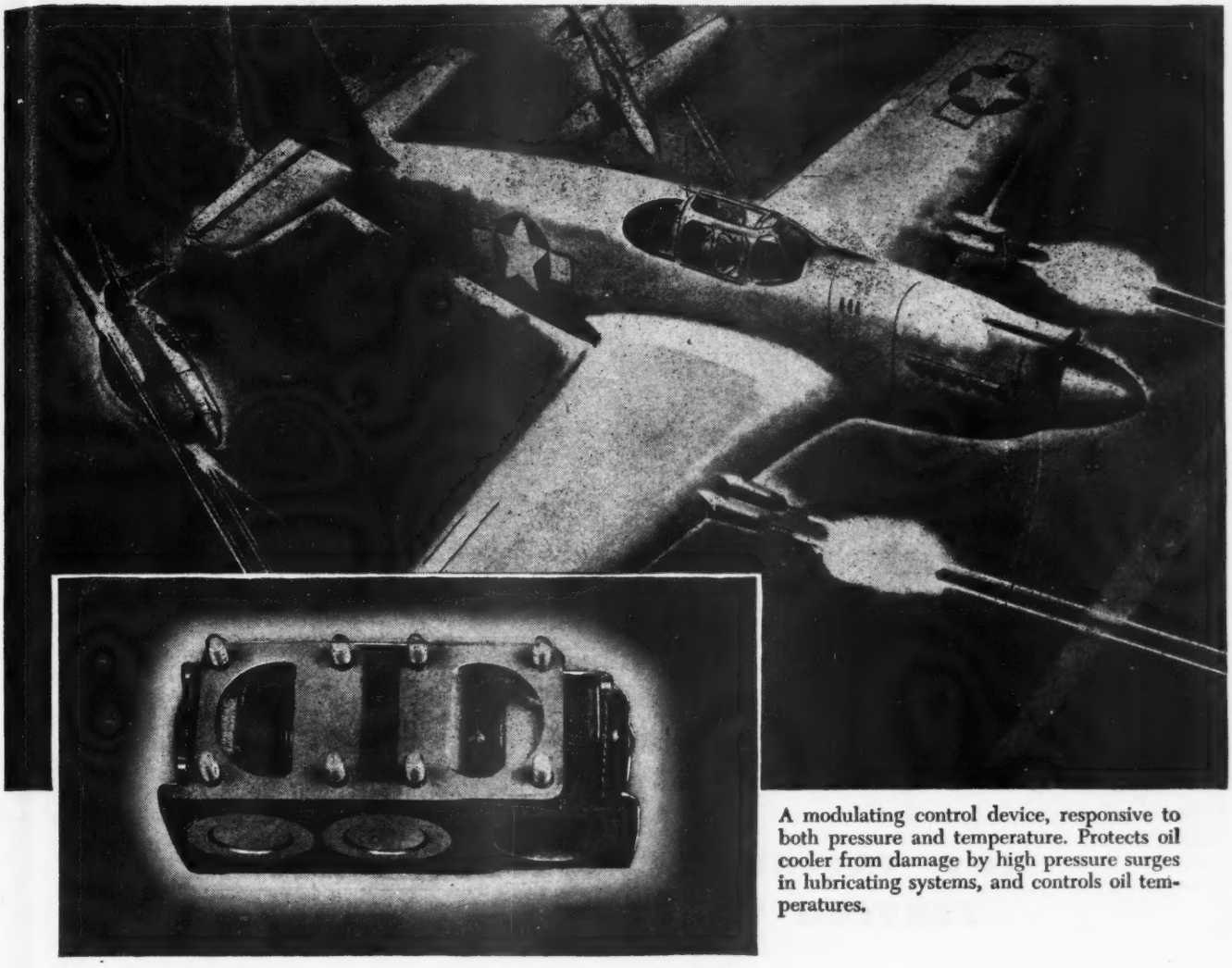

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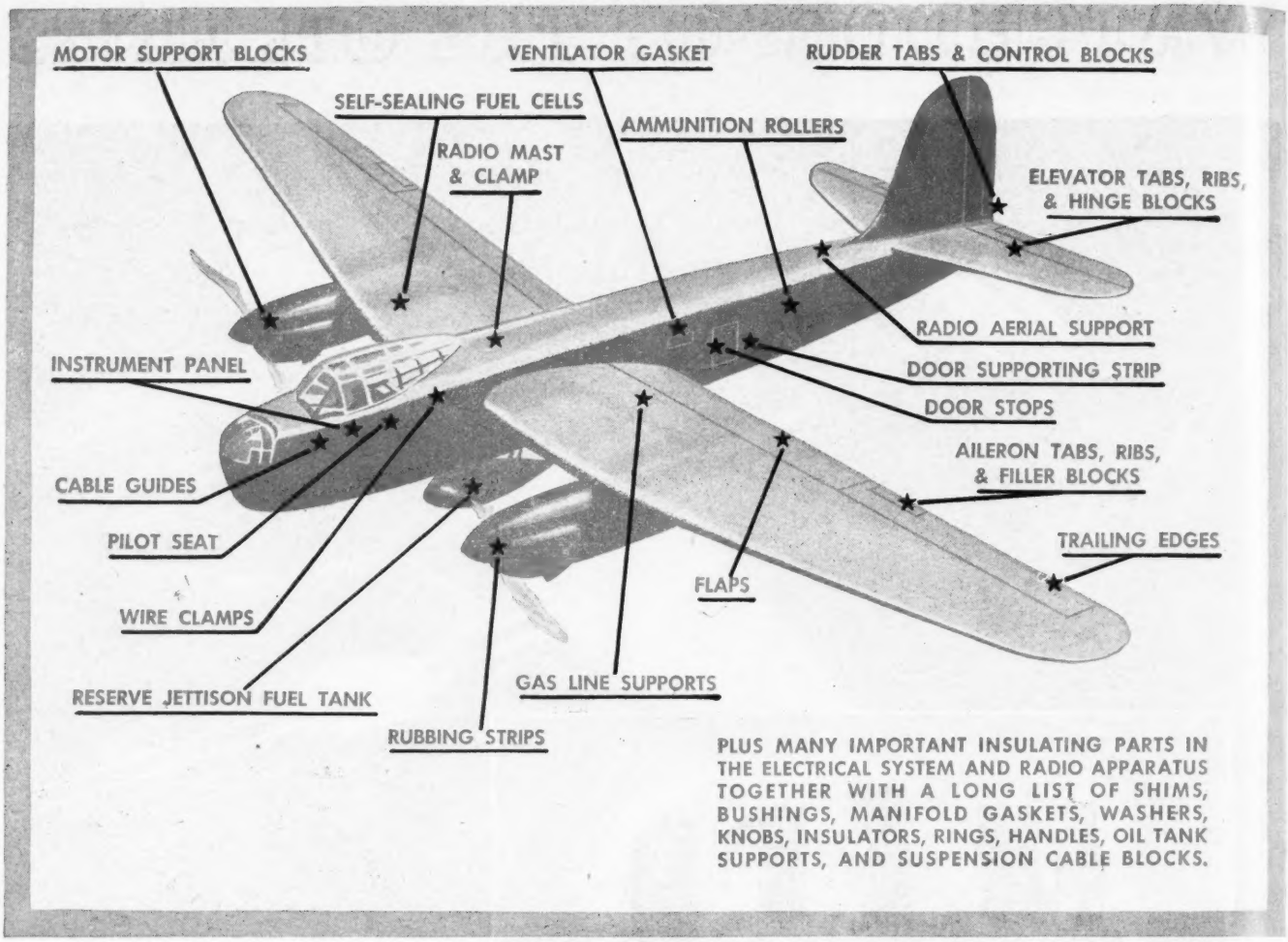
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identical planes, powered with air-cooled engines according to C. A. Stamm and W. E. McGravey, of the Chrysler Corp.

This potential power reduction, ascribed equally to reduced cooling and fuselage drag, permits the designer practically to eliminate cooling drag at higher speeds by selecting a suitable radiator and streamlining the nose of the fuselage, said these men. Knowledge of aircraft engine cooling requirements has increased rapidly during the war years. Describing their report as a pioneer treatment of over-all cooling-system problems and presentation of computations of the effect of variables, they suggested that, pending further developments, water is the best coolant, but it must be protected against freezing at high altitudes by using proper amounts of ethylene glycol.

Vincent C. Young, of Wilcox-Rich Div., Eaton Mfg. Co., described the value to aircraft engine performance and durability of proper design for inlet and exhaust porting. He proposed that the important port dimensions be determined from actual performance data, rather than theoretical considerations, and preferably should be based upon displacement, speed, and area.

J. P. Flannery, Aircooled Motors Corp., confirmed this point in his paper on Low Cost Cylinder Design for Commercial Airplane Engines. He cited one case where a very small change in the intake valve port caused a loss of 4 hp. per cylinder. He concluded that aircooled engines were the logical choice for light aircraft, and he concurred with Ricker that all-aluminum finned cylinders were a logical development for future aircooled engines. A. T. Gregory, of Ranger Aircraft Engines, here pointed out that aluminum snuff-cooled cylinders ran from 50 to 60 deg. cooler than with steel fins.

A paper presented in the diesel engine session will also be of interest to aircraft engineers. Tracey C. Jarrett, of American Hammered Piston Ring Div., Koppers Co., presented this data to show that with chromium-plated rings, even under abnormal dust conditions, cylinder wear is cut about in half. The data indicated that a 2,000 hp. engine operated for 590 hr. developed cylinder wear of only 0.003 in. when a porous chromium-plated ring was run in a chromium-molybdenum cylinder. With a plain cast-iron ring, 307 hr. of operation produced cylinder wear of 0.007 in.

Suitability of three types of synthetic rubbers for use on aircraft engines was reported by Dr. Gertrude H. Spremulli, of Ranger Aircraft Engines. She stated that Neoprenes show good general physical properties, heat and cold resistance, and moder-

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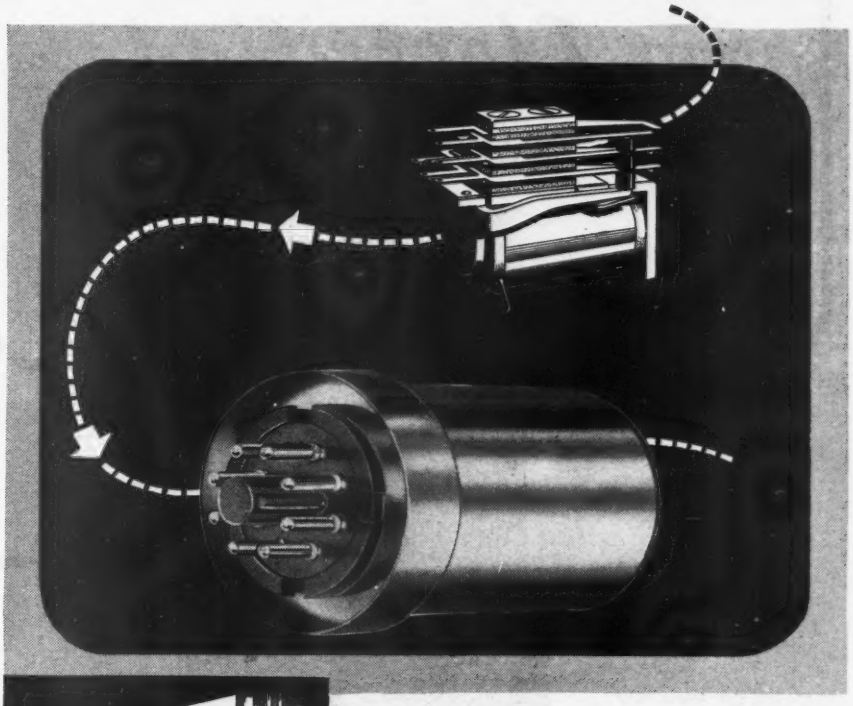

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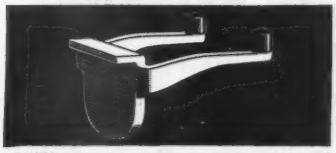
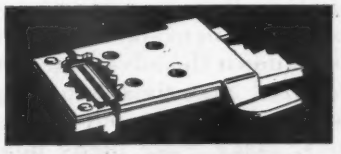
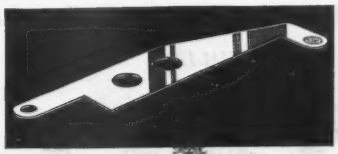


Heelpiece of magnetic metal, carefully annealed.



Hinge of "fatigueless" beryllium copper insures long life under vibration.



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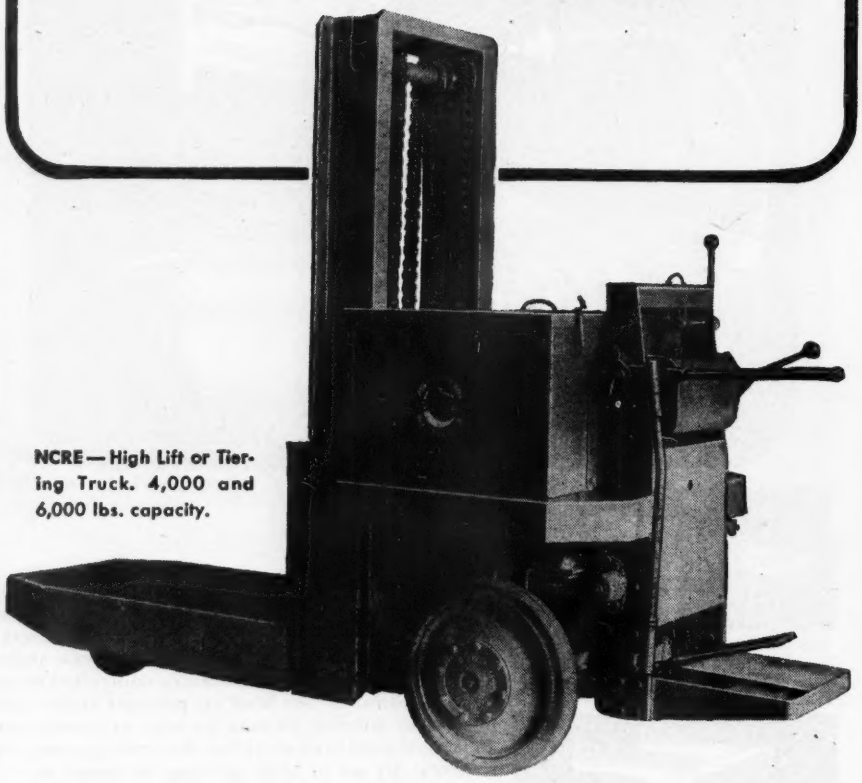

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ately good oil resistance. Buna N rubbers were reported as outstanding in resistance to oils and gasoline and to be capable of compounding for resistance to heat. And Buna S rubbers were characterized as having physical properties quite similar to those of natural rubber, plus good resistance to abrasion. She said exhaustive tests of synthetics indicate they may be used both as substitutes for rubber during periods of shortage and as replacements for rubber in some applications for which the synthetics are superior.

Selection of these synthetic rubbers for aircraft-engine applications was said to be a serious matter of application analysis and of laboratory testing both of raw stock and finished parts. Proper design of parts was reported also to be essential, and it was added that consideration must be given both to normal operating conditions and to the most unfavorable conditions which might be encountered in use.

Probably one of the most important papers presented was Difficulties with Engines Installed in Civil Aircraft, given by Stephen H. Rolle, chief, Power Plant Section, CAA. He presented an analysis of difficulties encountered in a 2½ yr. period from Jan. 1, 1941, to June 30, 1943. Engine failures in air carrier operations resulted in only one accident, one forced landing, and one airplane damaged during this period, but no personal injuries of fatalities. Ignition represented more than half of the total failures. Structural failures were about half of this number and those due to lubrication about one half as many as structural.

A far different picture was shown by non-air-carrier operations where there were 2,416 forced landings out of 2,658 engine failures. 1,459 resulted in plane damage, 187 in personal injuries and 36 caused fatalities. Engine structure failure contributed to nearly half and fuel systems only a little less. Of engine failure causes, broken exhaust valves were first, and crankshafts second. Of structural failures, stuck exhaust valves and broken piston rings were the most common causes.

J. O. Charshafian, project engineer, Wright Aeronautical Corp., explained how development testing could be carried out on the ground by suitable modification of the intake system to simulate altitudes. He also described their 150-hr. model tests and 600 hr. durability tests, further telling of the use of the Wright torquemeter in flight testing, whose use be advocated in all engines that were built with reduction gears, since it added so little extra weight and cost.

He explained how important this was for pilots of big multi-engine

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Soon the North Pole will need a marker — adequate identification for the post-war passengers on polar routes who'll want to tell their friends they've really seen it. Meanwhile American Bosch sticks to its war jobs — starting vibrators for positive ignition at all temperatures from equator to the arctic circle — aviation magnetos that have helped modern aircraft engines maintain service ceilings of seven miles and more — gasoline injection equipment that saves fuel, steps up pay load, increases engine performance and round trip military range. Whether the future will demand more and more production for military needs or a rapid changeover to transports for polar and other global routes, in research, design and production, American Bosch will continue to serve all branches of the internal combustion industry.

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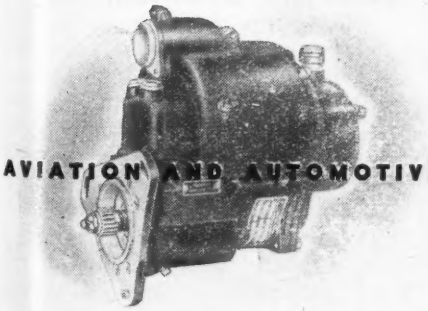

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The family airplanes of tomorrow are being built today for non-combat military needs. And Stewart-Warner is today making instruments for such planes. These instruments have the same dependability and ruggedness that millions now take for granted from the Stewart-Warner instruments in their automobiles.

And if family planes are to sell at prices within family budgets, the panel of instruments must be produced with these factors in mind: they must be made with the simplicity, ruggedness and precision necessary for the job, yet stay in line on cost.

When Victory releases the "family version" of these planes, Stewart-Warner will be ready with instrument panels—to help the aviation industry reach its goal of low-cost flying for everybody.

INSTRUMENTS BY

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planes with outboard engines "a block away" from the controls. Temperature and other indicating devices would not show an engine missing—nor could the pilot or engineer hear the trouble until something serious happened to the engine. With a torquemeter the trouble would be immediately shown, and the engine could be shut down before serious damage resulted.

In another paper, responsibility for the service life of assembled machine parts was placed upon the man with the wrench. He was held to be a factor 16 times more important than design, metallurgy, or processing. Just how much he tightens a nut, bolt, or stud was said to determine the ultimate working life of an assembly, according to J. O. Almen, of Research Laboratories Div., General Motors Corp., in his report on Torquing of Nuts in Aircraft Engines.

Good design and materials, heat-treatments, and superior manufacturing processes all are desirable, he said, but the fatigue strength of highly loaded bolts, studs, and nuts finally is determined by the man with the wrench—and how little, or much, he applies that tool in the tightening procedure.

He reported tests showing that increase in the initial tension on a bolt to 8,420 lb. from 1,420 lb. should increase fatigue durability to more than 5,000,000 stress cycles from 5,960. He said the tests further indicate that when a nut is tightened against reasonably rigid abutments to produce in the bolt a tension equal to or greater than the working tension load, virtually no stress change tapes place and the bolt's operating strength approaches its static strength.

Other findings were that nut tightness should be measured by the only reliable method—actual stretch of the bolt. Tension in the bolt, when measured by bolt stretch, should be 80 percent of yield strength either of bolt or abutment, whichever is weaker.

Proper selection of cutting oils is essential to successful machining operations, and the type of oil governs tool life, it was reported in a technical paper prepared jointly by H. L. Moir, J. S. Yule, D. J. Wagelin, and R. J. Moyer, of The Pure Oil Co. Their conclusions were: That, active sulphur in an oil prevents seizure between tool and chip; chlorine increases the strength of the lubricating oil film; in heavy cutting operations, the oil should have a high anti-weld property to resist heat and pressure; and that in light operations, active sulphur acts as an abrasive and decreases tool life.

Production has reached such a point on the C-47's at Douglas that it is now possible to work out numerous time-

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NO postwar job will ever compare with the urgency of wartime production. For while the war is on, a minute saved may mean a life saved, too.

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Acme consulting engineers have helped many a wartime producer to conquer production line problems. These same engineers will be equally helpful during the critical transition from war to peace.

Preliminary recommendations submitted without obligation.

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saving and material-conserving methods, according to D. L. Moseley, chief strength engineer of the company. Some of the most important changes have been the driving of hard "D" rivets and eliminating the ice boxes. By deep drawing methods, gas tanks are now being made in two pieces and welded together at the joint. This construction gives a tank 6 percent lighter and takes only 1/20 the time to build.

By designing curved skins without compound curves, large sheets can be rolled into shape up to 180 deg. curvature. These sheets replaced three formerly required and reduced rivets driven from 1,300 to 480. Also forming dies were eliminated. This rolled material is all in the hard condition. Installation time was reduced over 30 percent by automatic riveting with Erco machines. It is now being performed on parts requiring 3,665 rivets in 7 hr., whereas it took 28 by hand riveting methods previously. Extruded magnesium cargo floor beams 10 in. in depth are used. They are about 5 percent lighter and 25 percent stronger than the built up aluminum ones formerly used, and their cost is ⅔ that of the built up ones. Dowmetal 0-1 alloy was used.

Another interesting example described was the engine-mount ring which was first made from two steel forgings bolted together. To get production, this ring was cut into four pieces and these flash welded together in pairs to obtain interchangeable parts with those previously made. The four-piece ring cost ¼ as much as the two piece and 40 percent as much as a gas welded tubular ring that it replaced.

Lt. Comdr. Neil MacCoull, USNR of Lakehurst, gave one of the most interesting papers. This was on Transoceanic Air Cargo and analyzed the difference in performance of airplanes and lighter-than-air cargo carriers. Conclusions from the curves shown were that up to 3,000 to 4,000 mi. the plane, at much greater speed, could carry its loads with about 0.80 lb. of fuel per ton-mile while the airship could carry loads up to 8,000 mi. or more at a cost of 0.20 to 0.10 lb. of fuel per ton-mile. For cargo carrying over 4,000 to 5,000 mi., there was no comparison between the airship and the plane.

How the cargo delivered by airplanes was affected by speed was also shown. On a 3,000-mi. voyage, a maximum of 343 tons per month could be carried at 200 mph. At 120 mph. only 223 tons could be carried, and at 300 only 182 tons, with the same ship over the same distance per month with increased fuel consumption.

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Penn Modulating Temperature Control is available with an electric motor and screw jack or can be used with a suitable hydraulic valve to automatically actuate exit flaps or shutters on oil coolers, intercoolers and coolant radiators. Write for engineering details; no obligation. *Dept. A. Penn Electric Switch Co., Goshen, Ind.*

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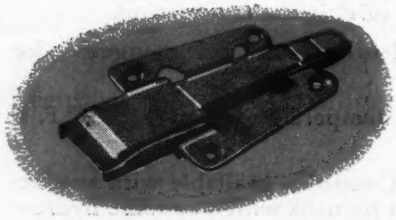
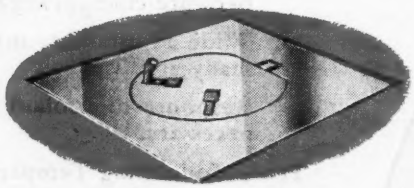
PRESS AND THE INSPECTION DOOR FLIES OPEN!

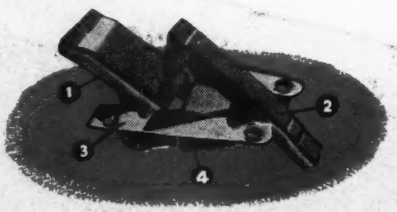
The new Hartwell door latch ends the tedious removal and replacement of inspection doors. Saves as much as 30 minutes on the inspection of a single plane. That means ships in action faster. Press the trigger of the Hartwell latch and the inspection door flies open! Press the bolt and it is locked shut! It is that easy and that fast! And it is economical!



NEW HARTWELL DOOR LATCH. This new inspection time-saver can be installed in a standard Army Air Forces cutout shown on print 43G2853. It is light—weighs less than ⅓ oz. *Patent applied for.*



FITS FLUSH. The Hartwell door latch fits flush with the inspection door. Where necessary two or more latches can be installed on a single door. For complete engineering details write or wire our Los Angeles office.



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Analytic Geometry

(*Continued from page* 149)

slope can be defined as m where $m =$ tan α.

When two points P^1 and P^2 are given, consider the line as the hypotenuse of a right triangle in which—

$$\tan \alpha = \frac{\text{side opposite}}{\text{side adjacent}}$$

and consider the opposite side to be the vertical side whose length is the difference in Y values of the two points. The side adjacent then will be the horizontal side whose length is the difference in X values.

$$\text{Therefore } m = \tan \alpha = \frac{Y_2 - Y_1}{X_2 - X_1}$$

Example: Given two points on a line P_1 (1, 3) and P_2 (13, 5) determine the slope m and the angle of inclination α.

$$m = \frac{X_2 - X_1}{Y_2 - Y_1} = \frac{5 - 3}{13 - 1} = \frac{2}{12} = .16667$$

Angle α therefore is 9 deg. 27 min. 44 sec. (See Fig. 3a.)

The b value in the equation is the constant locating the line with respect to the origin. As there can be any number of lines having the same slope, the constant b is necessary to limit the location of the line.

As previously stated, b equals Y when X equals zero. In other words, as the line crosses the Y axis the X coordinate of that point is zero. The Y coordinate of that point then is the b term as used in the equation. (See Fig. 3b.)

$$b = Y_1 - mX_1$$

By substituting the above into the general equation, we have

$$Y = mX + (Y_1 - mX_1)$$

Examples: (a) Given a line having a slope of .350 and passing through a point having coordinates of (8, 6), determine the equation. (See Fig. 4a.)

$$Y = mX + b \qquad b = Y_1 - mX_1$$

$$b = 6 - .35\ (8)$$

Therefore $Y = .35X + 3.20$ $b = 3.20$

(b) Find the equation of the flap trailing edge passing through points P_1 and P_2 having coordinates of P_1 (24, 136) and P_2 (102, 112). (See Fig. 4b.)

$$m = \frac{Y_2 - Y_1}{X_2 - X_1} = \frac{112 - 136}{102 / 24} = -.30769$$

Negative value of m shows that the line moves forward as it goes outboard. The equation would then be—

$$Y = mX = b$$

$$b = Y_1 - mX_1$$

$$b = 136 - (-.30769)\ (24)$$

Therefore $Y = -.30769X + 143.385$

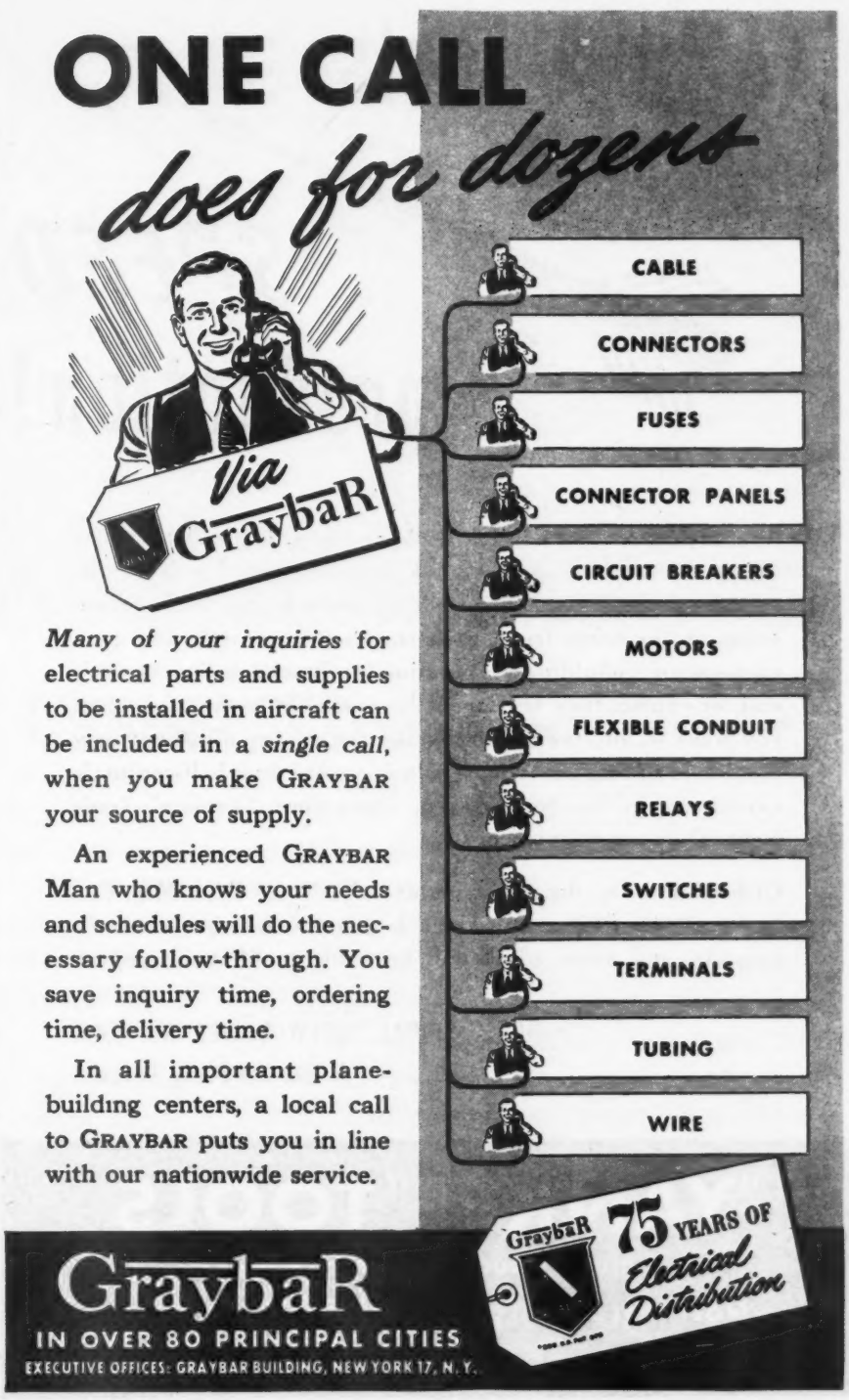
$$b = 143.385$$

One of the benefits of the analytic method of calculating equations of lines is the ability to determine points of intersection between a line and a plane, or between two planes. It makes no difference whether the plane is a simple wing station normal to the wing reference plane, or a double canted station, for the location of the point of intersection can be easily obtained.

Any one familiar with the old method of finding the intersection of lines and planes realizes that it requires an involved layout and an excellent knowledge of descriptive geometry. When large layouts are required, the accuracy obtainable is quite often inadequate and may often be the cause of failure in coordination of structural parts.

By means of analytic geometry it is a simple matter to obtain the desired dimensions within .001 in. The work required involves an expenditure of no more than a few minutes and the whole problem can be solved on a single sheet of paper.

One of the most useful of the above benefits is the ability to determine the intersection of two canted planes. When seen in the plan view, these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planes appear to be two straight lines.

Point of Intersection of Two Lines

Coordinates of the point of intersection of two straight lines can be determined by solving their equations simultaneously for X and Y. There can be only one possible point of intersection for any two non-parallel lines. Cordinates of that point must therefore satisfy both equations.

Following is the method suggested as one of the most efficient ways of determining the location of this point:

Given two lines L_1 and L_2

Equation of L_1 $\quad Y = m_1 X + b_1$

Equation of L_2 $\quad Y = m_2 X + b_2$

When two lines intersect, the coordinates at that point must be the same for both L_1 and L_2. As a result, in the above equations the Y values must be equal, therefore—

$$m_1 X + b_1 = m_2 X + b_2$$

This has temporarily eliminated Y and we have only the function of X to find. By transferring quantities we have—

$$X (m_1 - m_2) = - b_1 + b_2$$

$$\text{Therefore } X = \frac{- b_1 + b_2}{m_1 - m_2}$$

Having found X, it is easy to determine Y by substituting the X value into either original equation.

Above can be simplified by placing one equation over the other and subtracting, thereby eliminating the Y.

$$Y = m_1 X + b_1$$
$$Y = m_2 X + b_2$$
$$O = (m_1 - m_2) X + b_1 - b_2$$

$$\text{Resulting in } - X = \frac{- b_1 + b_2}{m_1 - m_2}$$

Examples: (a) Given equations of two straight lines in one plane, determine coordinates for point of intersection. (See Fig. 5a.)

$$L_1 \quad Y = \quad .287X - 24.32$$
$$L_2 \quad \underline{Y = - .113X \times 35.68}$$
$$0 = \quad .400X - 60.00$$
$$X = 150.00$$

By substituting the value of X into either of the original two equations we can then find Y.

$$Y = \quad .287\ (150) - 24.32 = 18.73$$
$$\text{or } Y = - .113\ (150) + 35.68 = 18.73$$

(b) Determine the location where the rear spar intersects a canted station when the equations of both are known. (See Fig. 5b.)

$$\text{Rear spar} \quad Y = - \quad .26385\ X + 124.000$$
$$\text{Cant. station} \quad \underline{Y = \quad 3.13615\ X - \quad 72.500}$$
$$0 = - 3.40000\ X + 196.500$$
$$X = 57.794$$

$$Y = - .26385\ (57.794) + 124.000 = 108.751$$
$$Y = \quad 3.13615\ (57.794) - \quad 72.500 = 108.751$$

The above, when interpreted in dimensional form, states that the point of intersection occurs at wing station 57.794 and 108.751 in aft of the leading edge at wing station O.

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Order from your supply house, or write North Bros. Mfg. Co., Dept. AV-344, Phila., Pa. Furnish priority ratings whenever possible, and every effort will be made to fill your orders.

Illustrated above:
"YANKEE" SPIRAL SCREW DRIVER NO. 130A
A Size for Every Purpose

"YANKEE" TOOLS
make good mechanics better
North Bros. Mfg. Co., Phila. 33, U. S. A.
Established 1880

Engine Test Cells

(*Continued from page* 165)

and maintain control of the engine undergoing tests, without ever getting up from his desk, protected by three windows of shatter-proof plate glass.

Each of the cells has many pneumatic control valves. Switches, controllers, motors, and valves control carburetor air temperature and pressures, gasoline flows and temperatures, engine cylinder temperatures, singly or in groups, oil flows and temperatures, cell ventilation, and Prestone and oil temperature for liquid-cooled engines. In cells for experimental testing, the engineer may simulate, without leaving the control desk, all the varied conditions the engine might encounter when flying to 40,000 ft. and when traveling from the heat of the tropics to the sub-zero temperatures of the Arctic.

Because exhaust gases are released directly into the cell, the danger of explosion is constantly present, unless adequate means are available to get rid

...in Electronic Control Systems for Bombers

MINNEAPOLIS-HONEYWELL stands first in the application of electronic control systems to bombers. Except for radio communication which has been in everyday use for a number of years, Minneapolis-Honeywell makes the only Electronic Control Systems that are standard equipment on all heavy bombers.

Today everyone is familiar with precision bombing and the increased accuracy made possible by the Minneapolis-Honeywell Electronic Automatic Pilot. Yet this is but one of a number of M-H electronic controls in daily use in all war theatres.

When the war is won, the same engineering ability that has put Minneapolis-Honeywell first in aircraft electronic control systems for bombers will be available for the transport and cargo planes destined to occupy so important a place in our future life. Minneapolis-Honeywell Regulator Company, Aeronautical Division, 2792 Fourth Avenue South, Minneapolis 8, Minnesota. Branches in all principal cities.

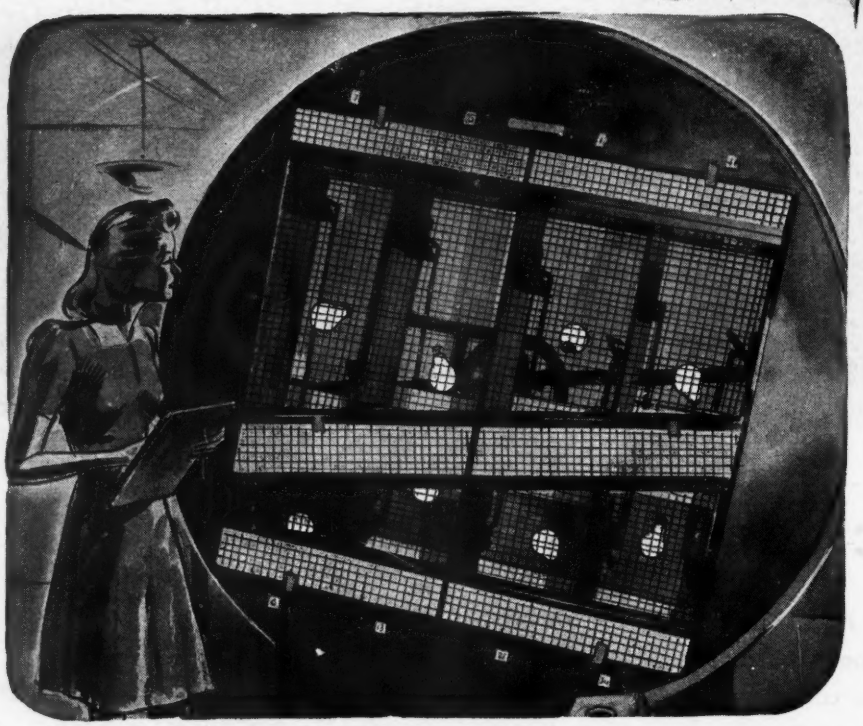
MINNEAPOLIS **Honeywell**

AERONAUTICAL DIVISION MH

AERONAUTICAL INSTRUMENTS

This girl gets PAID to bounce G-E bulbs downstairs!

1. Bouncing lamp bulbs downstairs isn't a practice we recommend. But in G-E's lighting laboratory there's a machine specially built to give lamp bulbs the punishment they'd get if you *were* to bounce them down a flight of stairs.



2. This is it . . . a big revolving drum with eight compartments that bounce the bulbs from heights of six to 30 inches. Main object is to test strength of lamp filaments. They aren't special lamps—just ordinary G-E bulbs. Filaments of the surviving lamps are carefully examined after each bounce.

"TO MAKE LAMPS STAY BRIGHTER LONGER"
The Creed of G-E RESEARCH

3. This is only one of more than 480 tests and inspections given to standard G-E Mazda lamp bulbs. Why all this bother? Simply to insure uniform high quality in every lamp wearing the G-E monogram, whether a special lamp for war or the G-E lamps you use in your plant.

BUY AN EXTRA WAR BOND NOW!

G-E MAZDA LAMPS

GENERAL ELECTRIC

Hear the General Electric radio programs: "The G-E All-Girl Orchestra" Sunday 10 p. m. EWT, NBC; "The World Today" news, every weekday, 6:45 p. m. EWT, CB

of these gases quickly. Hence each test cell at the new plants is three stories high, with the top floor containing a large ventilating fan which takes air through sound-proofed ducts leading from the outside. Air is directed through a special system of ducts down to the next, or middle, floor where the engine itself is mounted, and this air is spilled into the cell and over the engine. Amount of air is regulated by a damper system which automatically permits enough to flow over the engine to maintain desired cylinder temperatures.

After the outside air is passed over or around the engine and mixed with the explosive exhaust gases, it is removed by an exhaust fan which draws all of it toward the rear of the cell before pulling it through ceiling vents. The fan placed here has more capacity than the supply fan, with the result that there is a slight negative air pressure within the cell during running tests. This system has the added advantage of preventing exhaust gases from escaping into the operating room or into the hallways of the plant itself.

A static pressure regulator lights a warning light should the cell static pressure ever rise above that of the surrounding corridor and control room. A remote bulb temperature controller is set at approximately 275 deg. to give a warning should air temperature leaving the cell rise above that point.

Below the cell is another floor which contains the large concrete piers on which the engine is mounted and which also contains the fittings, valves, and other connections to the engine block.

During the course of an engine test it is necessary to take temperature readings of cylinder heads, oil in and out, carburetor air, coolant, gasoline, and a number of other temperatures throughout the engine. Some of these checks are sufficiently important so that individual indicating thermometers of the millivoltmeter type are used, permanently connected.

Since there are a number of readings to be taken it is essential that the instruments respond rapidly and accurately. Vibration exists in test cell control rooms, hence an instrument unaffected by vibration is best.

The Brown Instrument Div. of Minneapolis-Honeywell has developed a high-speed precision electronic indicator with type BS thermocouples for Army aircraft use in the range from 0 deg. to 600 deg. Installed in the cells which the company has helped to furnish, this electronic potentiometer, connected through a multiple switch to 16 or 24 points on the engine, provides almost instantaneous readings. Being electronically balanced, it is vibration proof.

The action is so rapid that by the time the test cell operator throws the selector switch to the desired point and gets ready to write down the temperature reading, the instrument is accurately in balance and indicating the temperature of the cylinder head or other point. This, incidentally, is another adaptation of the Brown Flight Recorder, which was used in flight testing the B-19 and which recorded 144 temperatures, stresses, and strains on the huge plane every 3½ min.

Test cell operations are varied in accordance with the type of engine to be tested but, in general, there are eight cell types. These are:

1. ***Production test cells*** in engine manufacturers' plants which are used for "green" or "break-in" runs and "acceptance" test runs on new engines. The majority of cells in any plant will be for this purpose.

2. ***Experimental test cells*** present in engine manufacturers' plants as well as research organizations, such as Wright Field. Special tests may be run to simulate high or low altitude, Arctic, tropic, or any of a number of conditions which affect the operation

Accuracy is their Job . . .

. . . and ours too!

GUN CREWS depend on split second accuracy to bring down enemy planes. It is their skill plus the gun's accuracy that determines their success or failure in scoring hits.

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Yes, our "score" is high too, because we know that if we fail on our job, those boys can't do theirs.

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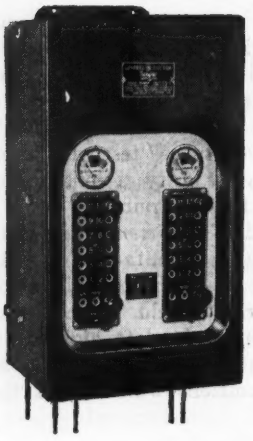
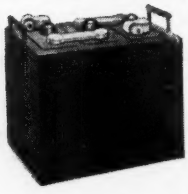


This Battery Charger



will charge 3 to 72 Cells of Battery at 2 to 6 Amps. or 3 to 36 cells at 2 to 12 Amps.

This Full-Wave Tungar is a truly versatile battery charger. At 2 to 6 amperes it will handle 24 6-volt batteries, or 12 12-volt batteries, or 6 24-volt batteries. At 2 to 12 amperes it will handle 12 6-volt batteries, or 6 12-volt batteries or 3 24-volt batteries. It is a strong, toughly built unit designed to provide fast service. It will give a fast or slow charging rate or a combination of both. And it's economical, highly efficient and very easy to operate.

Why not get the help of G-E Tungar and Metallic Rectifier Engineers in providing maximum efficiency in charging batteries?

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Gentlemen: Please send additional details on Tungar Rectifiers for battery charging to:

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GENERAL ELECTRIC

of an engine. They are also used to test or analyze new designs. The control of these cells is usually more elaborate than in the case of production cells since a greater variety of records and conditions are required.

3. *Repair test cells* at repair bases for commercial airlines, Army Air Forces, and the Navy. These cells are used to "run in" overhauled engines, also to check their power delivery, oil and gasoline consumption, etc. Usually their temperature and pressure limitations are somewhat less stringent than in the case of production cells for the reason that the engine is already the property of the using service.

4. *Club propeller test cells* employing specially built propellers (called "clubs") with short stubby blades. These are used to provide a load on the engine being tested. The power developed is used entirely in moving air in the test cell.

5. *Power recovery cells,* now installed in several plants, in which the airplane engine is connected through a coupling to a motor generator. The generator functions as a motor to start the engine, and after it is running, it is used to load the engine by acting as a generator. Current so generated is used in the plant. During the first part of the engine test run with speeds in the lower ranges, the power generated is dissipated as heat since the motor generator cannot be run at sufficient speed to develop electric current having the proper characteristics for plant consumption. However, this represents a small part of the total run, and the majority of power developed is reclaimed.

6. *Dynamometer test cells,* quite similar to power recovery sells except that it is possible to check the actual torque delivered at any speed very accurately. These cells are used in experimental work and also in setting up calibration curves on engines so that they may be run and checked in power recovery or "club" propeller test cells.

7. *Flight test propeller cells,* similar to propeller cells except they usually have a more streamlined airflow approach to, and recovery from, a standard propeller mounted on the engine. These cells are used for experimental work, such as propeller vibration tests, as well as for model testing for engine design and acceptance by the purchaser.

8. *Single cylinder cells* in which an engine with only one cylinder is mounted. They are used for design-engineering testing to try out different types to obtain design information regarding proposed changes or improvements in engines. Usually, these cells are found only in engine manufacturers' plants.

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Are Metal-Cutting EXPEDITERS!

Removing gates and risers from steel, cast iron, manganese bronze, hard and soft brass, aluminum and magnesium castings, as well as many other metal cutting jobs, are handled with great dispatch and surprising savings on TANNEWITZ VARIABLE SPEED BAND SAWS. And since they are available in any 3:1 speed ratio from 100:300 to 1000:3000 blade feet per minute, with instant adjustment to intermediate speeds, one machine serves ideally for cutting a variety of materials. Made with 30', 36" and 42" wheels.

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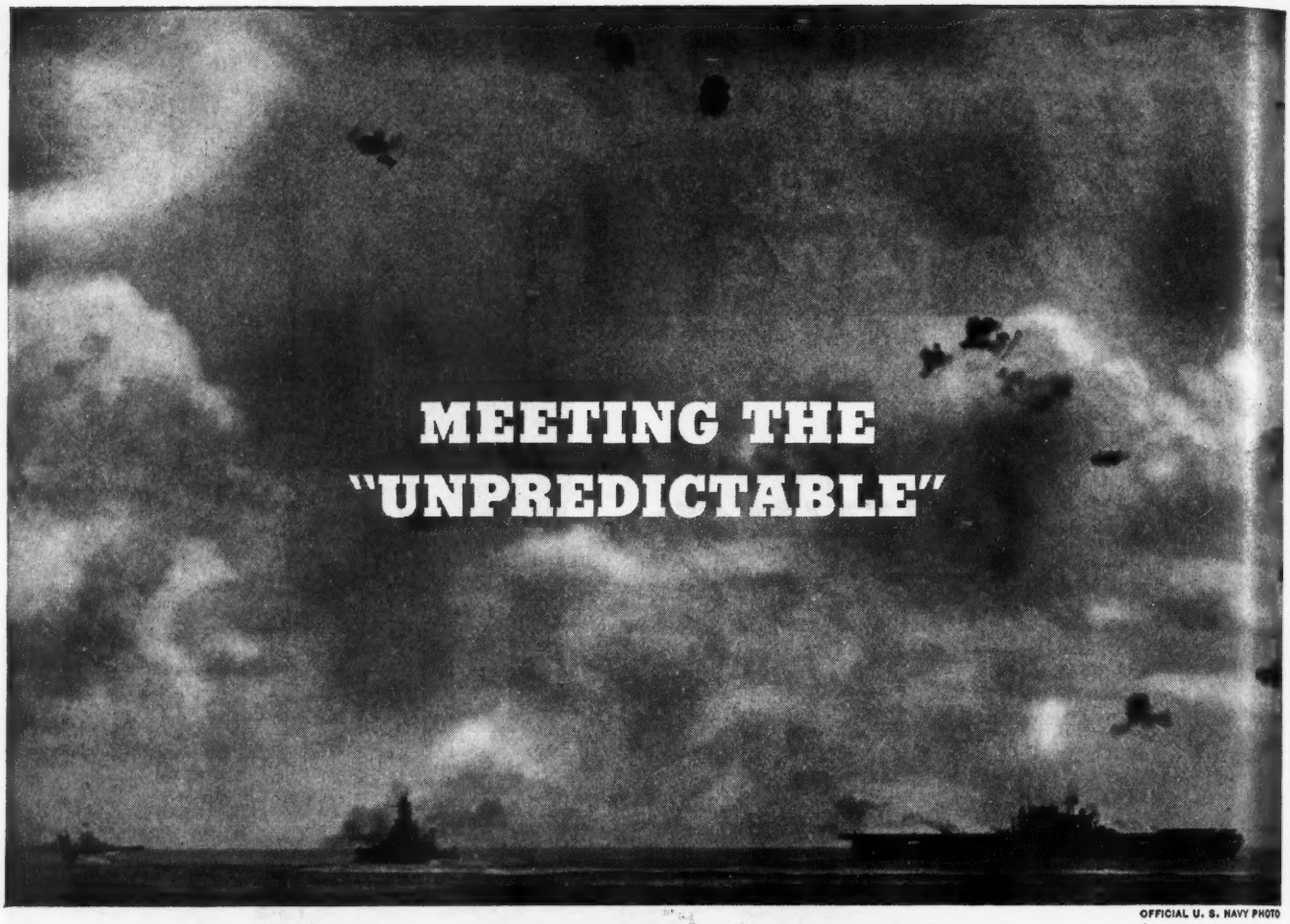
THE TANNEWITZ WORKS, GRAND RAPIDS, MICHIGAN

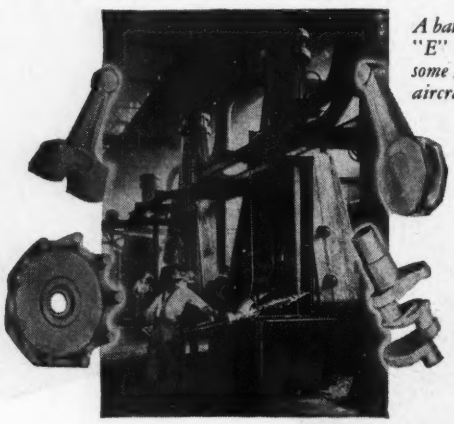


OFFICIAL U. S. NAVY PHOTO

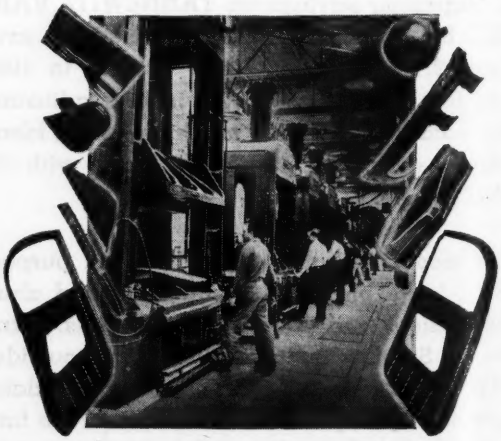
WHY DROP FORGINGS AND CECOSTAMPINGS ARE A WAR TIME "MUST"

THE DEMANDS of war are ruthless—nothing can be left to chance. When the ability of a metal part to stand up under battle strain is being calculated, the war time designer must allow for "unpredictable" stresses and strains. That is why the demand for drop forgings in this war has risen to heights heretofore undreamed of—why drop stamped sheet metal parts of light weight and high tensile strength (Cecostampings) are required in unbelievable quantities. Drop forgings and drop stampings have the extra strength combined with light weight, that makes all the difference between success and failure in the performance of airplane, tank, gun, or other mechanized piece of battle equipment.

Chambersburg Hammers and Cecostamps are contributing heavily to the veritable torrent of drop forged parts and Cecostampings that are going into the mechanized forces of the Allies pressing forward on every battle front. These Hammers and Cecostamps will be contributing as heavily in the days of Peace that are ahead—if the lesson taught by war is remembered . . . the lesson that there can be no substitute for the strength, toughness and light weight imparted to metals by impact die-forming.



A battery of Chambersburg Model "E" Steam Drop Hammers and some typical drop forgings for aircraft engine parts.



A battery of Chambersburg Cecostamps and typical Cecostampings for aircraft fuselages, doors, exhaust pipes, etc.

CHAMBERSBURG ENGINEERING CO.

CHAMBERSBURG, PENNSYLVANIA

Minneapolis-Honeywell has installed control instruments and devices for the above types of cells with the result that the operation of all of them is managed and controlled automatically and remote from the engine. At some Army repair bases, operation of the cells is handled by one test engineer, who operates the remote control switches and valves, assisted by a member of the Women's Army Corps who takes down all operational data, indicated on the recording instruments. At a number of engine manufacturing plants, "run in" tests are managed entirely by workers, some of whom have frequently been trained in less than two months.

Contrasting with these examples are the methods used prior to the prewar expansion. Older type test cells required the constant attention of three trained men, at least one of whom was usually a graduate engineer specifically trained in engine operation. These men, in order to control the engine, had to operate valves by hand and, at times were compelled to go into the cell itself to make adjustments while the engine was running at full power. Inadequacies of the older type cells occasionally resulted in accidents which completely ruined the engine and equipment. Worse, there was sometimes serious injury or death of operating personnel.

Perhaps the importance of test cell operation is best indicated by the fact that a service crew, say, somewhere in the South Pacific, can now mount a new engine and send the plane off to combat without taking time to see if it can stand the gaff. Truth of the matter is, of course, that all engines delivered to the armed services are ready for combat. Engine makers and test cell men know that—so do crew chiefs.

Cruise Control

(*Continued from page* 179)

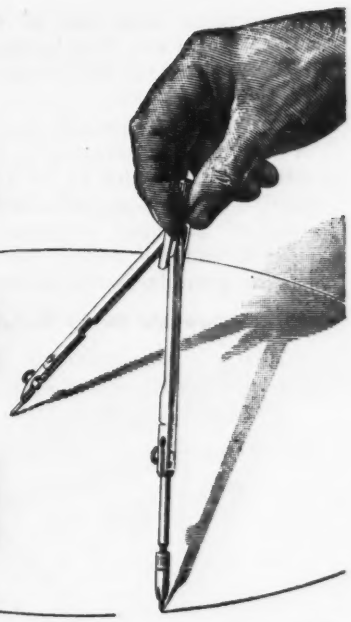
weight-history be accurate.

The problem of loading a modern large airplane can become rather complex when it is considered that there are usually as many as five general locations in the airplane where a load may be placed and that this load may be, and usually is, a rather heterogeneous mass, having articles as dense as aircraft engines and as bulky and light as sections of stove pipe for far-north camps.

There are a number of reasons why an airplane must be loaded correctly. The important rules are:

1. The allowable gross weight of the airplane must not be exceeded.
2. The load must be so located that its center of gravity falls within definite limits.
3. The maximum structural loads of

To Technical Men NOW IN WAR PRODUCTION



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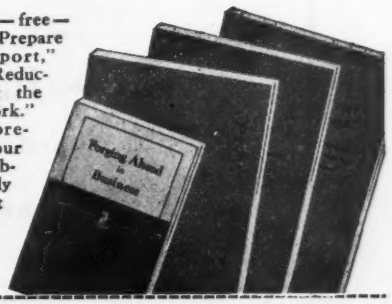

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the airplane must not be exceeded. (Usually this is a floor loading factor. It may, however, be a wing loading limit.)

The above points will be discussed in the following paragraphs. Note that this is not intended to be a comprehensive study of aircraft loading, but some of the main problems will be covered and the reasons for various loading procedures will be considered.

Allowable Gross Weight

This is a complete study in itself. We are accustomed to thinking of this as a simple problem because up to now, in most cases, the maximum allowable gross weight of an airplane has been some definite fixed figure. For example, the Douglas DC-3, now used all over the world, has a maximum gross weight for commercial passenger service within the United States of 25,200 lb. This is a definite figure and therefore simple to use.

In the near future, however, it is expected that the maximum allowable gross weight for a given airplane will be a variable because of the following factors.

(a) Weight must be such that the aircraft may have one engine fail just after breaking the ground, and either land and stop within the boundary of the field or continue on with one engine, clearing a 50 ft. obstacle at the end of the field. It is obvious that this weight will be greatly influenced by temperature, so that from a given field the maximum allowable gross weight will vary from day to day and season to season. The allowable gross weight for a given airplane will also vary from one field to another on the same day.

(b) Allowable landing gross weight will probably be restricted because of landing speed. This indirectly will influence the allowable takeoff gross weight since the difference between the normal takeoff gross weight and the landing weight may be less than the amount of fuel which will be used for the proposed flight.

For example, an airplane may have an allowable gross weight for take off of 50,000 lb., and the landing gross weight may be limited to 40,000 lb. There is thus 10,000 lb. difference between takeoff and landing gross weight. If the flight is comparatively short, such as from New York to Washington, there may be required only 400 gal. of gasoline weighing 2,400 lb. to reach the destination. Thus if the airplane took off at full 50,000 lb., it would arrive at the destination weighing 47,600 lb. and thus be too heavy for landing.

In order for this not to happen, the takeoff gross weight would be 40,000 lb. plus 2,400 lb.=42,400 lb., and the airplane would then conform to the landing gross weight limitation. Obviously, to utilize the full capabilities of an aircraft, such as the one pointed out in the example, the airplane should be used on routes where normally 10,000 lb. of fuel would be used on each flight.

It is thus evident that as aircraft become larger and more complex, even such a simple matter as takeoff gross weight may become quite involved.

Loading Within Safe Limits

If an airplane is loaded so that the center of gravity falls outside the specified position, it will usually result in an airplane being dynamically longitudinally unstable. If an airplane is longitudinally stable it should be possible to trim the ship so it flys "hands-off" at a given power setting. After the airplane has been trimmed at some stable airspeed, push the wheel forward, putting the nose down, letting the airplane pick up 40 or 50 mph. more than the stable airspeed.

When the wheel is released, the airplane will nose up of its own account

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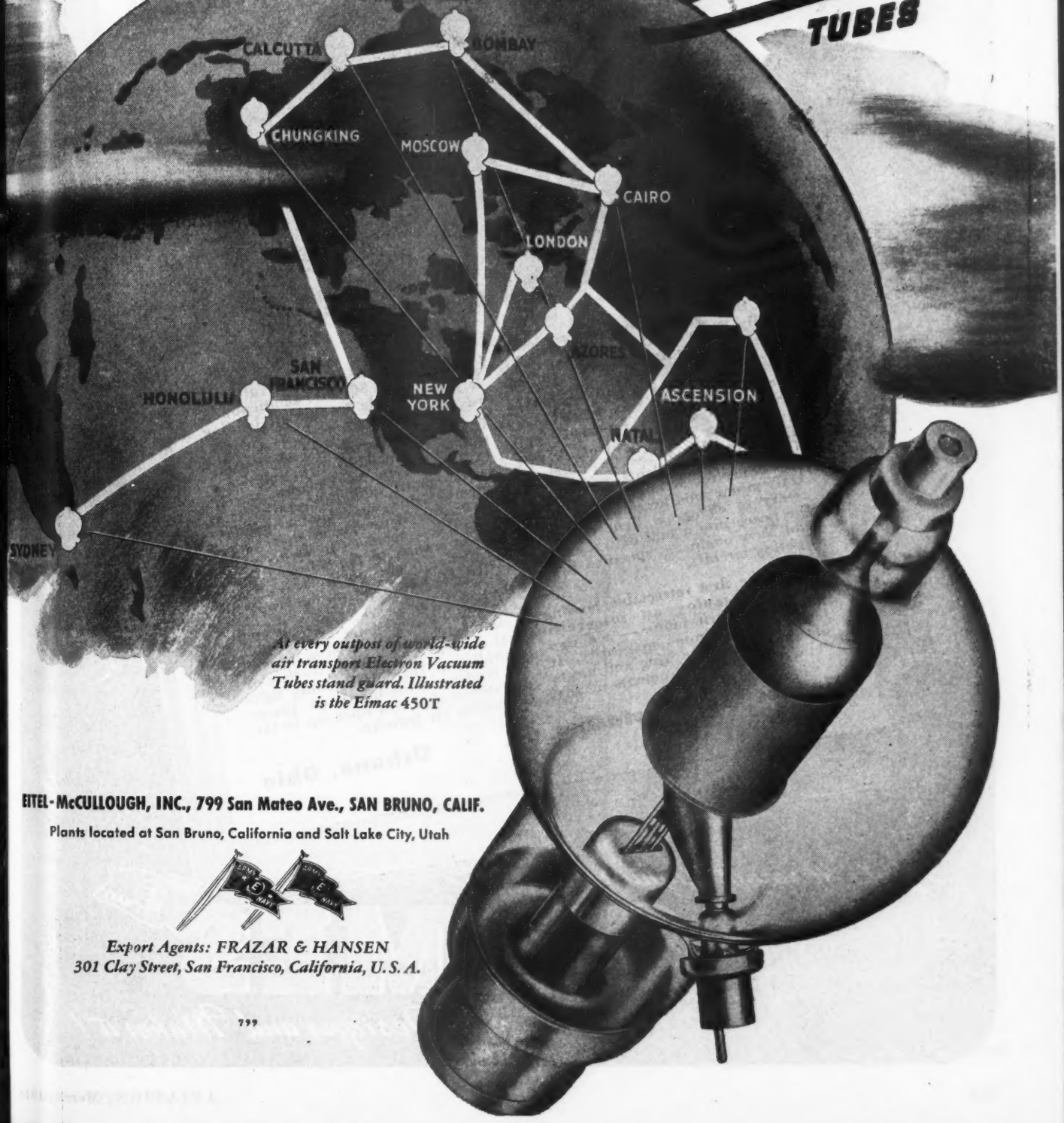

At every outpost of world-wide air transport Electron Vacuum Tubes stand guard. Illustrated is the Eimac 450T

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It was the first retractable landing light to employ an integrally mounted electric motor — a design feature of definite superiority. It fits snugly into the wing and meets the streamline requirements of any plane design. With a powerful beam of more than 500,000 candlepower, it is adjustable to suit all landing requirements.

It is the only basic, electrically-controlled, retractable light used on U. S. Army and Navy planes, as well as on many allied aircraft. The integral Grimes-made motor includes features such as special steel gears and oil-less bearings to assure reliable operation in the sub-zero temperatures of the north, as well as in the burning heat of the tropics.

Designed for peace, but dedicated to war, the Grimes Retractable Landing Light will return to its original service after Victory — that of providing a fully dependable light for landing at the many new places of interest that will open up to the peacetime air traveler.

Grimes Manufacturing Co. **Urbana, Ohio**

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Designs and Makes it!

and begin to climb. It will climb to a higher altitude and have a lower airspeed than the altitude and airspeed at which it was trimmed. The nose will start down finally and the airspeed will again increase. However, the nose will come up of its own accord at some lower airspeed than that at which the wheel was originally released. The airplane will gradually ascend and descend, the oscillations becoming smaller each time. The oscillations will usually damp out to less than 50 ft.

The airplane is thus dynamically longitudinally stable. If the C.G. is not within the specified limits, the airplane is either tail heavy or nose heavy, depending on whether the C.G. is ahead of or behind the desired range.

Position of C. G.

Desired range of positions of the C.G. is usually referred to as some percent of the mean aerodynamic chord. If the wing were 100 in. from the leading edge to the trailing edge, the desired positions of the C.G. might be from 16 in. to 32 in. from the leading edge. This would be 16 percent to 32 percent allowable limits for the C.G. Since the wing supplies the lift which supports the airplane, it is obvious that the center of gravity of the load must occur over the point of lift of the wing, otherwise the aircraft would not balance.

. A balancing effect is derived from the tail, but for simple analysis, let us assume the wing lift must be directly under the load. It is thus evident that to compute the desired position of the load for an airplane, some means of determining the center of gravity is necessary, or the problem must have been computed beforehand.

For airplanes in which the load may be placed only in the fuselage, it is sufficient to have "load stripes" painted along the side of the fuselage. A load stripe is shown for given load weights. Thus, if 2,000 lb. is to be placed in an airplane, it is placed so the center of the load is opposite the 2,000 lb. stripe. Similarly, a 4,000 lb. load would be placed opposite the 4,000 lb. stripe. This system is simplicity itself and is possible only when the load may be placed in one compartment. When several compartments exist, precomputed tables are sometimes published showing the percent of the total load to be placed in each.

Loading Large Airplanes

Large airplanes with several load compartments are not so simple. The well known method of computing the C.G. of a load is used.

Referring to Fig. 1, assume we have a large plank with six weights on it and it is desired to balance the plank and weights on a cross bar. In order to determine the center of gravity of the loads, we proceed as follows:

Assume the plank is free to turn around the left hand edge. Each downward force then has a tendency to turn the plank clockwise. The tendency to turn (the moment) is equal to the weight times the distance to the left end of the plank. Thus the moment of the load A is Aa, the moment of the load B is Bb, etc. Thus the sum of the moments about the left end of the plank caused by the downward loads is $Aa+Bb+Cc+Dd+Ee+Ff$.

The lift must equal the sum of the downward forces $(A+B+C+D+E+F)$. For the plank to be in equilibrium, the lift at distance X must exert the same tendency to turn (moment) that the downward loads do, but in the opposite direction. Otherwise the plank would rotate about the front end. The moment of the lift is $LX=(A+B+C+D+E+F)\ X$, since $L=A+B+C+D+E+F$. To find the position in which lift will balance the load, the moments are equal, or $X(A+B+C+D+E+F)=Aa+Bb+Cc+Dd+Ee+Ff$

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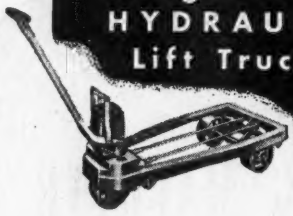

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Therefore

$$X = \frac{Aa+Bb+Cc+Dd+Ee+Ff}{A+B+C+D+E+F}$$

$$= \frac{\text{Sum of moments of each load}}{\text{total loads}}$$

Referring to Fig. 2, we see the plank can be considered as an airplane. The various loads are the weights of the loads in various compartments, including the weight of the airplane itself. If we take moments about the nose of the airplane, the C.G. may be found by taking the sum of the moments of each load divided by the total gross weight. This would be a tedious calculation unless precomputed tables were available, such as Table I.

Very often, as is the case in Table I, the moments are divided by some common factor and called "balance units." However, the principles remain the same. The sum of the balance units is added and the resulting center of gravity is found by reference to Fig. 3, which is merely a graphical means of finding the C.G. expressed in percent mean aerodynamic chord.

An example of the use of the tables and chart follows:

Assume an airplane itself weighs 50,000 lb. and its balance units are 1,850, with 5,000 lb. to be placed in the cabin at station 600, and 1,000 lb. in the belly compartment, and with 12,000 lb. of fuel to be carried:

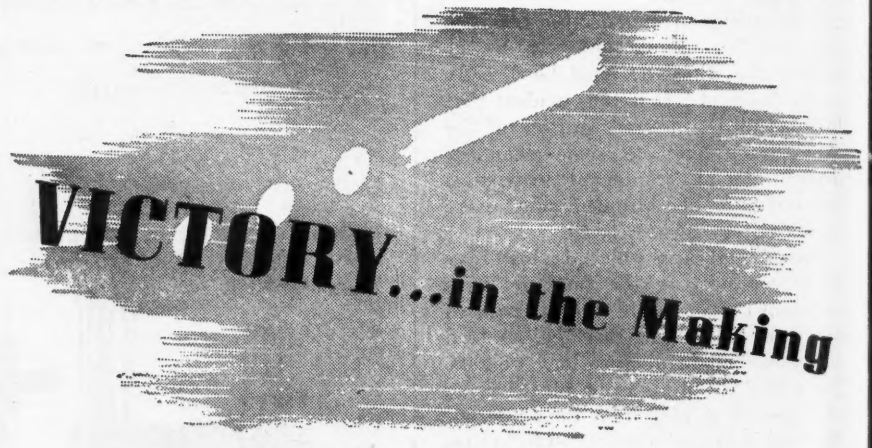
Description	Weight	Balance Units
Empty oper. wt. ...	50,000	1,850
Cargo, cabin sta. 600	5,000	300
Cargo, belly	1,000	59
Fuel	12,000	481
Total gross weight .	68,000	2,690

At the intersection of the 68,000 gross weight line on Fig. 3 it is seen that 2,690 balance units yield a C.G. of 24.8 percent MAC at 68,000 lb.

Reference to a table of limits for the airplane will indicate if this is satisfactory. On most modern aircraft approximately 1¢ to 32 percent is satisfactory. This should always be checked definitely for each airplane.

The structure in an airplane is usually designed for some maximum load which should not be exceeded. For example the floor might be able to support 200 lb./sq.ft. This must not be exceeded. If a 3,000 lb. load has a floor area of only 10 sq.ft., this would result in a floor loading of 300 lb./sq. ft., which is excessive. The load should in this case be supported on planks so that the actual weight will be spread over a greater floor area, resulting in a lower floor loading per square foot.

There may also be a maximum load per running foot of cabin length. This also must not be exceeded. In some airplanes the total gross weight is a



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variable depending upon the amount of fuel in the wing tanks. In effect this limits the maximum fuselage load allowable. It is thus evident that before loading an airplane, the person responsible for loading the plane should be thoroughly familiar with all the limitations of the airplane, both structural load limitations and center of gravity positions.

C.G. Position Does Not Effect Airspeed

There is a popular misconception that if the center of gravity is rearward or forward of the point which yields 0 deg. of elevator trim, the airplane will cruise slower than if it is trimmed out to 0 deg. elevator trim.

Very careful flight tests in which the center of gravity was shifted from the most forward to the most rearward allowable C.G. position with constant power showed that no change in air speed resulted. Actually the only extra drag caused by using nose-down elevator trim is the drag of the elevator riding slightly lower than usual. This increment in drag has been found to be negligible.

This does not mean that correct loading is unimportant. It is very important. An incorrectly loaded airplane may be unstable in flight and hard to handle in rough air, and severe gusts may cause structural failures, if the loading limitations are not carefully observed. In addition to the above, an overloaded airplane may not survive an engine failure in a critical phase of the flight, such as during takeoff, when a correctly loaded airplane would probably come through with no trouble.

Airplanes must be correctly loaded.

TABLE I—BALANCE UNITS FOR VARIOUS LOADS

a. Main Cargo Load

Cargo wt. lb.	Sta. 500	Sta. 600	Sta. 700	Sta. 800
1,000	50	60	70	80
2,000	100	120	140	160
3,000	150	180	210	240
4,000	200	240	280	320
5,000	250	300	350	400

b. Fuel

Gal.	Wt. lb.	Balance Units
500	3,000	121
1,000	6,000	242
1,500	9,000	362
2,000	12,000	481

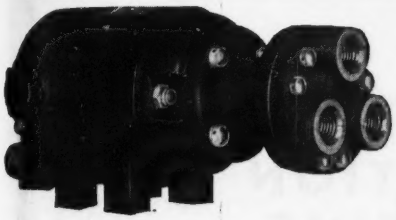
c. Belly Compartment

Wt. lb.	Balance Units
200	12
400	24
600	35
800	47
1,000	59

Fuel Measures

(*Continued from page* 163)

near the C.G., that 900-lb. error is going to cause you to lose faith in your load adjustor. Since center of gravity positions become more and more critical for long range cruising, an error like this will cause trouble. In this case the 900-lb. load was not aboard



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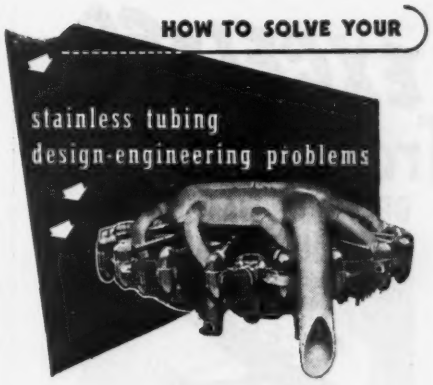

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when thought to be, therefore some enterprising gentleman might think that this is an excellent way to get more payload. But don't lose sight of the fact that these 900 lb. were not conjured up for traffic purposes but represent weight that was needed for gas according to the flight plan.

Our payload advantage results only from the original testing. If we do not have facilities for measuring the fuel density for the actual test work and use 6 lb./gal. by reason of the long standing reputation of that criterion, our payload suffers. From the attached curves of temperature versus density (Fig. 1) it can be seen that the 100 octane fuels only weigh as much as 6 lb. when the temperature is quite low, so this is not a good figure for summer testing. If we use 6 lb. and find out later that 5.75 would have been accurate enough, we will suffer in payload to the extent of .25 lb. for every gallon loaded.

That does not seen much, does it? But consider the 3,000 gal. fuel load at .25 lb./gal. This gives us 750 lb. that we did not know we had. Why should we control our maintenance weights down to the last ounce when an error like this can creep into the calculations with a seasonal temperature fluctuation?

To control this problem accurately, only a small outlay in cash is represented, and that is saved a hundred times over on the first flight. Only a minor deviation from loading procedures, as they exist at present, is necessary. Hydrometers are needed, and these may be secured to read in specific gravity or in API units, but it is just as easy to calibrate them directly in lb./gal. and it saves another conversion. In summarizing the flight plan, a fuel load figure in pounds is picked off the new chart. This pound figure must be divided by the actual density in order to produce a gallon figure that will register on the station loading pumps.

Variations of this will crop up during winter, for example when an aircraft with its tanks half full of relatively warm fuel is rolled out of a hangar to be fueled from a tank of cold fuel. Two hydrometer readings must then be taken and a mean value used, depending upon the ratio of the amount already on board to the amount actually loaded. With fuel curves in pounds, fuel density readings must be taken religiously. It is the follow-through that counts, otherwise the pilot will be shortchanged.

In flight on large aircraft, where pound loading is practical a flight engi-

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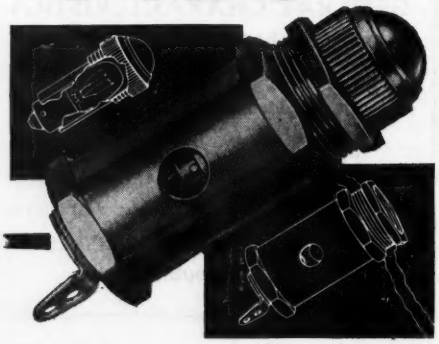

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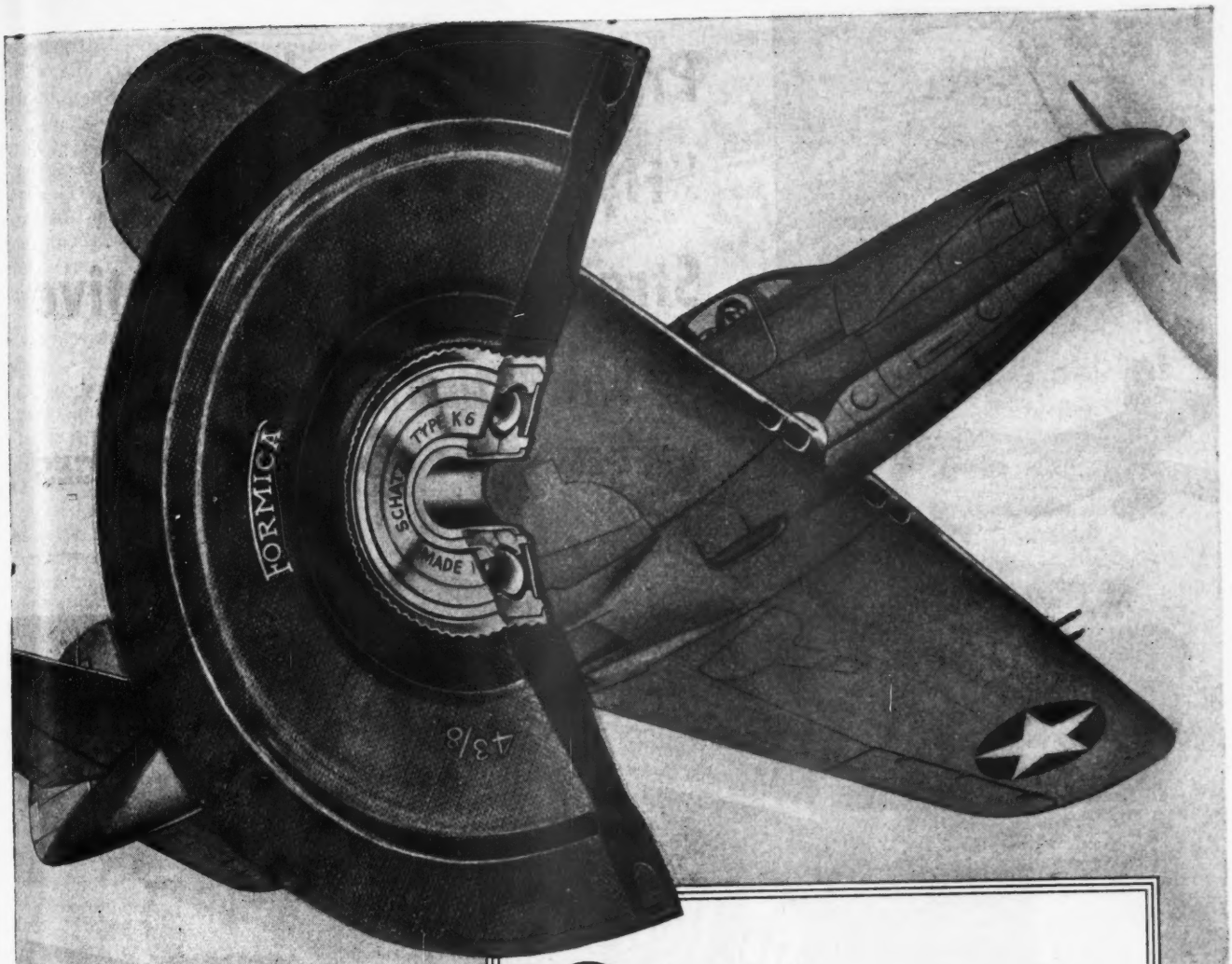

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neer is usually carried who minds the fuel flow and is also concerned with the running gross weight of the aircraft. To calculate from this gallon gages he must continue to use the density conversion factor. Two courses are open: He may use the mean value determined at the time of loading without too great an error, provided the temperature variation throughout the flight is not too radical, or he may carry a chart showing how his fuel will vary with temperatures encountered.

On a protracted high-altitude flight, naturally the fuel will tend to assume the temperature of the surrounding air. This is more apparent with integral wing tanks. In the case where fuel is loaded at a warm temperature at sea level and flight follows at low temperatures, the engineer may wish to change his density factor gradually to that value charted for the low temperature. We might put temperature indicators in the tanks, but a close estimate usually will cut down the error to a minor amount. It is the extremes that we must guard against.

Fig. 3 is a "Howgozit" chart for determining fuel required at various times during a flight.

Let us summarize the operations that are necessary in providing for an accurate weight control: Actually, we may break up the procedure into two distinct divisions—flight operations and flight engineering. Flight operations is interested mainly in providing an accurate total fuel poundage, whereas flight engineering is interested in an average density to control fuel flow and record gross weight enroute.

An airport control form (see Fig. 4) may be used jointly by flight control and the station mechanic to arrive at the total load. Procedure:

1. Determine fuel required from cruising charts for specified altitude, power setting, etc.
2. Issue request form to station mechanic.
3. Station mechanic then determines amount of fuel already in aircraft, its density and poundage.
4. Station mechanic also calculates amount to be loaded from storage tank, measures storage tank density, and computes gallonage necessary for use on the station or truck fuel meters.
5. Total pounds loaded on board is entered, and the form is returned to flight control for entry on clearance.

Thus far, the procedure is interesting to the flight engineer only because of his joint responsibility in regard to total fuel. The mean or average fuel density determination is his next concern. A chart similar to that in Fig. 5 may be designed by him to compute this mean density by the following schedule:

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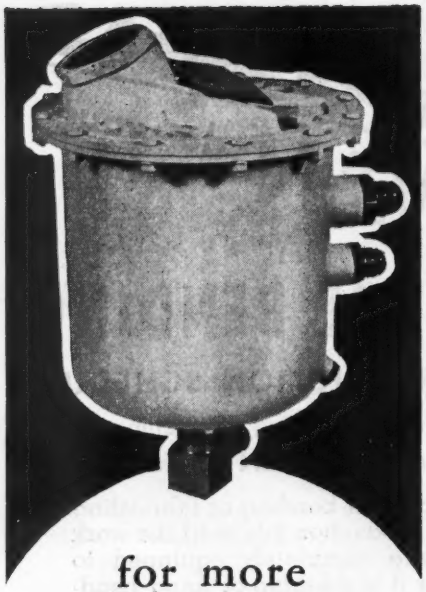

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$$\text{Percentage} = \frac{\text{Loaded fuel}}{\text{Total fuel}} \times 100$$

2. Connect storage tank density and aircraft tank density with line on chart.

3. Enter chart at percentage loaded, proceed vertically to line, thence horizontally to mean mixed fuel density. Example:

(*a*) Airport tanks.....5.90 lb./gal.
(*b*) Aircraft tanks.....5.80 lb./gal.
(*c*) Percentage loaded.....30 percent
(*d*) Mean density.....5.87 lb./gal.

"Indian" Aerating

(*Continued from page* 150)

A refrigeration system was definitely out, because such equipment had long before been diverted to the synthetic rubber industry. We studied, instead, a number of methods based on an evaporative principle. First of these was the air-wash principle, which led to another known as natural-principle cooling. The latter is a method whereby water temperature is lowered in a cooling tower, circulated through a bank of coils over which quantities of outside air are passed, cooled, and introduced into the conditioned space. This method, like that of the air wash, proved unsatisfactory because of the liming of radiators in much the same manner that nozzles in air washers become clogged.

Liming has been, and still is, a bugaboo. This is due to two causes: Dust in the air and water hardness. The dust acts as an aggregate; the hardness as a cement. And the two combine to make a concrete-like substance which plugs up the radiators of the natural-principle system, or the sprays in the air washer and the condensers in the refrigerated jobs.

P. M. "Pat" Tidmarsh, head of the Tucson firm, had been installing evaporative coolers of all types for years. He opposed the air-wash and natural-principle methods and recommended use of the evaporative cooling pad. To prove the latter system was more suitable, he took us to a local ten-story hotel employing it. A natural-principle system had originally been installed there, but proving unsatisfactory, the hotel engineers did away with the coils and cooling tower and installed instead a large excelsior pad through which water was slowly dripped from pipe installations at the top. The pad proved just as efficient as the natural-principle installation and much less trouble to maintain. A principle that almost every private home in Tucson had used for years, it had never been considered practical for larger buildings. But the hotel proved

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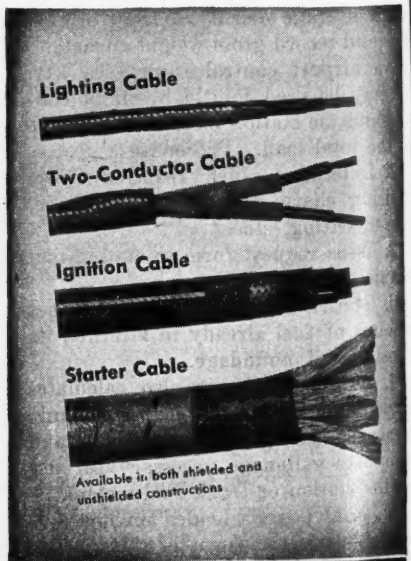

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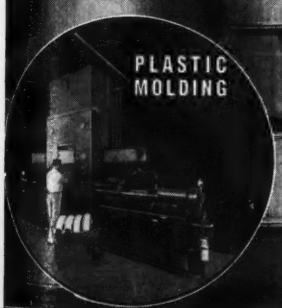

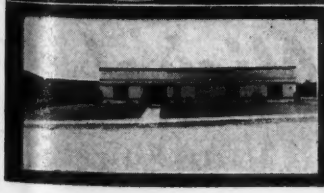

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One reason the equipment holds up so well... thanks to the foresight of design engineers... is that many of the critical parts are made of Nickel alloyed materials.

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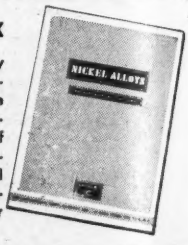
Hence, the use of Nickel is now so widespread that Nickel Alloys fortify nearly all kinds of mining and milling equipment parts... from drill bits and crusher frames to skips and cages, from ball mill liners to mine car axles.

Throughout the years of research and planning behind this progress, it was our privilege to cooperate with the engineers who desired help in the selection, fabrication, and heat treatment of alloys. Whatever *your* industry may be... if you'd like to have such assistance... counsel and printed data are available on request.

New Catalog Index

New Catalog C makes it easy for you to get Nickel literature. It gives you capsule synopses of booklets and bulletins on a wide variety of subjects—from industrial applications to metallurgical data and working instructions. Why not send for your copy of Catalog C today?



★ *Nickel* ★

THE INTERNATIONAL NICKEL COMPANY, INC., *67 Wall St., New York 5, N. Y.*

Under the abrasion test....

"AT THE end of 5000 cycles of rubs—felt against felt and 2 rubs per cycle—the eighteen Booth felt specimens were measured for wear. Only 4 specimens showed greater than 3.4% decrease in thickness; and 5 showed less than 2.0%."—From lab. report.

Abrasion-resistance is but one of the many characteristics closely controlled in the manufacture of Booth "prescription" felts.

THE BOOTH FELT COMPANY
482 19th Street Brooklyn, N. Y.
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APPLICATION CHART AND SAMPLE KIT . . . Contains swatches of S.A.E. felt types, with specification tables. Write for it. (No sales follow-up.)

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Booth
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PRECISION CUT FELT PARTS

otherwise, and it was decided to make a similar installation at the Consolidated Vultee plant.

One of the objections raised to the evaporative pad installation was the fact that the pads are hard to keep clean. Various methods have been attempted to keep them clean, including installation of a filter in front of the pad. While this latter is no doubt a good suggestion, we did not believe it necessary. It is the function of the pad both to cool and to filter. Dust in the air must settle somewhere, and the method worked out was to let it collect on the pads, then wash it off by water circulated through them. Replacing the entire pad when it becomes dirty is more sound, both from an economic and maintenance standpoint, than installing additional dust filters. The whole operation is kept in one place, and the pads will remain at top efficiency at all times if properly maintained.

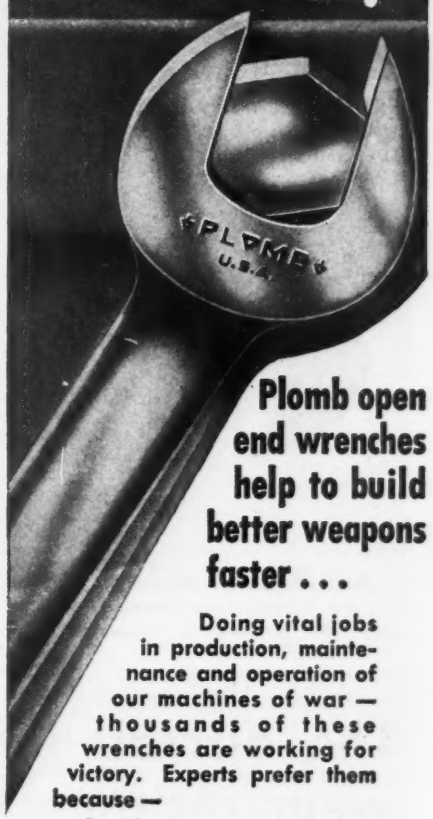
Along the roof, on the sides of each hangar, lean-to-shaped pent houses were built. On each, one side comprises a mammoth pad of excelsior, held in place by heavy net-type wire. For the entire plant eight pent houses were built, with a total pad area of 5,712 sq. ft.

In each pent house, large blowers, ranging from 22,500 to 40,000 cu. ft. per min. capacity, and powered by 5, 7½, and 10 hp. electric motors, were installed and connected to a system of air ducts leading to the areas to be conditioned.

Over the top of the pads we ran ½-in. galvanized pipe, perforated at regular intervals so that a steady supply of water could be kept dripping downward through the pads to keep them constantly moist. At the bottom of each pad a catch pan and pump was placed, making it possible to use the same water (which had been considerably cooled after its first trip through the pad) over and over again. As the blowers suck the 1,000,000 cu.ft. of dry Arizona air through the damp pads each minute, it is cooled by evaporation, then blown into the huge hangars where *Liberators* are readied for battle.

Admittedly not as efficient in many respects as a refrigeration system, the evaporative pad is still efficient and economical. It can be used as a straight-filter air-blower system to give the offices and hangars a complete change of air every 8 min., while acting as a cooling system. And it is highly important that every care be taken to keep delicate instruments and engines in the conditioned space free of all dust. The pads are simple, readily removed, and easily replaceable, making it possible to maintain a con-

All set for action!



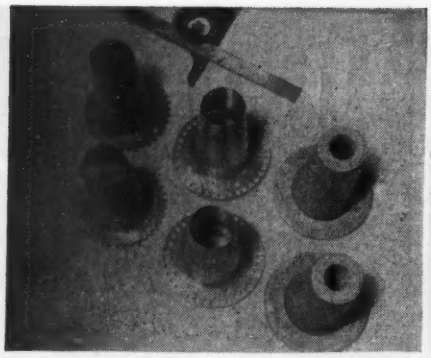
Plomb open end wrenches help to build better weapons faster . . .

Doing vital jobs in production, maintenance and operation of our machines of war — thousands of these wrenches are working for victory. Experts prefer them because —

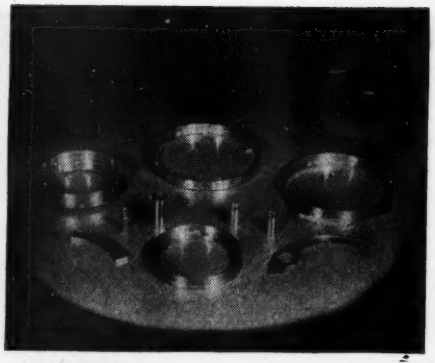
1. **They are precision-built for efficiency—*they work better.***
2. **Light, finely balanced yet rugged, *they are safer.***
3. **Design and material make them *last longer.***

Open end wrenches in all sizes and styles are but one of many hand tool lines within the complete Plomb Line. All are manufactured to highest quality standards for better, safer, longer-lasting service. Get the Plomb tools you need for your war job from the friendly Plomb dealer near you. — *Plomb Tool Company, 3519 Terminal Annex, Los Angeles 54, California.*

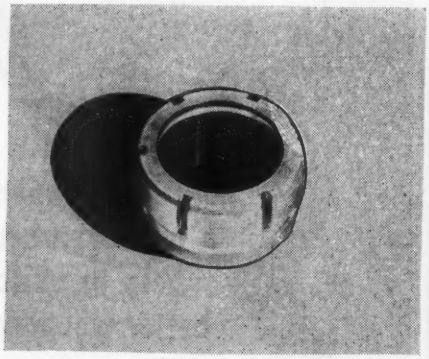
PLOMB



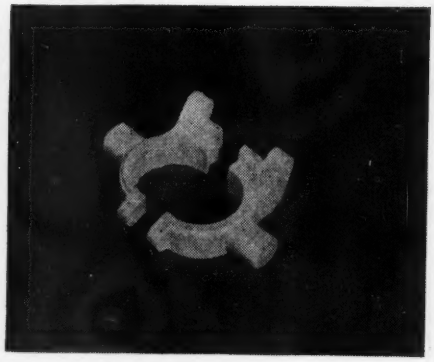
PROPELLER These Ampco Metal propeller blade bushings are typical of 9 applications in aircraft propellers.



ENGINE 16 parts of Ampco Metal (including bushings, valve parts, cam parts, etc.) are found in typical aircraft engines.



LANDING GEAR At least 18 parts of this vital mechanism are customarily made of Ampco Metal. (Illustrated: Packing nut.)



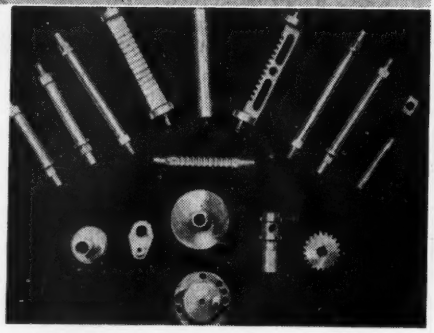
TAIL WHEEL Usually protected in at least 4 places with Ampco Metal. (Illustrated: Tailwheel yoke.)

The aircraft industry relies on *wear-resisting* AMPCO METAL— *for its margin of safety at vital spots*

Where severe conditions at critical points call for alloys of closely controlled properties, you find this superior alloy of the aluminum bronze class — in practically every American plane that flies today. Behind its consistent performance is a quarter-century of metallurgical specialization—resulting in a product that lasts several times as long as ordinary bronzes. Ampco's broad facilities make it available in practically every desired form.

Write for bulletins.

AA-2



WINDSHIELD WIPER — parts of Ampco Metal protect this mechanism against wear and failure.

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The Metal without an Equal

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Please send "Ampco Metal in Aircraft" and File 41 of Engineering Data Sheets.

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stant supply of clean, fresh air at all times.

Because the evaporative pad system has an efficiency in almost direct ratio to the proportion of moisture in the air, its output on a rainy day is somewhat impaired. But the rainy days during the hot summer months are few, and the temperature on such days is cool enough to eliminate the need for maximum efficiency from the evaporative system.

In May, invariably a hot, dry month when the average temperature is apt to be about 105 deg. F., one couldn't ask for better cooling. June is almost equally good. The rains, if they are coming, appear in July and August, and the evaporative system will, accordingly, be less efficient. September is hot and dry again, and by October you can forget about cooling.

If you take a dip in a pool in Tucson in May, a drop of water clinging to your body will tend to cool to 65 deg. which, allowing for an air temperature of 105 deg., means a variation of 40 deg. In July and August, when the temperature is around 95 deg., that same drop of water, due to the higher humidity, will tend to cool to 72 deg., a variation of only 23 deg.

No one expects the evaporative cooler to do that well. We admit that the present installation is not the final answer to air conditioning, but considering the priority situation and the need of vital supplies in other than air condition work, we believe the installation is 90 to 95 percent satisfactory. We are willing to admit that 5 to 10 percent improvement could be made, but we feel that the job is basically well laid out. We are keeping the huge *Liberator* hangars at around 85 deg.

In the hot months, we now have the hangar air as dust-free as possible and our workers are comfortably cool, whereas just outside the hangar door it is 105 in the shade—with very little shade.

Airlines Play Safe

(*Continued from page* 161)

housing the fire pump and the location of water storage tanks. Such occupancies should not be exposed to the hazards of fire or explosion originating in other structures.

Fire-Resistant Construction

It goes without saying that all structures should be built of fire-proof materials. Walls of masonry supported on steel framing, fire-proofed steel floor and roof framing, and floor and roof slabs of reinforced concrete afford the best protection for the types of fires and explosions that may occur at an overhaul and maintenance base.

Keep Runways Open with WALTER SNOW FIGHTERS And Start Flying . . . When the Snow Stops!

You're ready to swing back to normal operation the moment visibility clears after a snow storm, when your airport is equipped with Walter Snow Fighters. There's no "hangover" of snowed-under runways to keep planes grounded. Walter Snow Fighters have the speed and capacity to stay ahead of any blizzard . . . keeping runways constantly open!

The new Walter 250 H. P. Snow Fighter travels at 20-30 miles per hour . . . clears a 28 ft. width in one run . . . throws snow far to the side to prevent the formation of dangerous banks. It never slips, never stalls, never wheel-spins—because Walter Four-Point Positive Drive delivers the motor's great power to FOUR driving wheels, according to their traction at any instant.

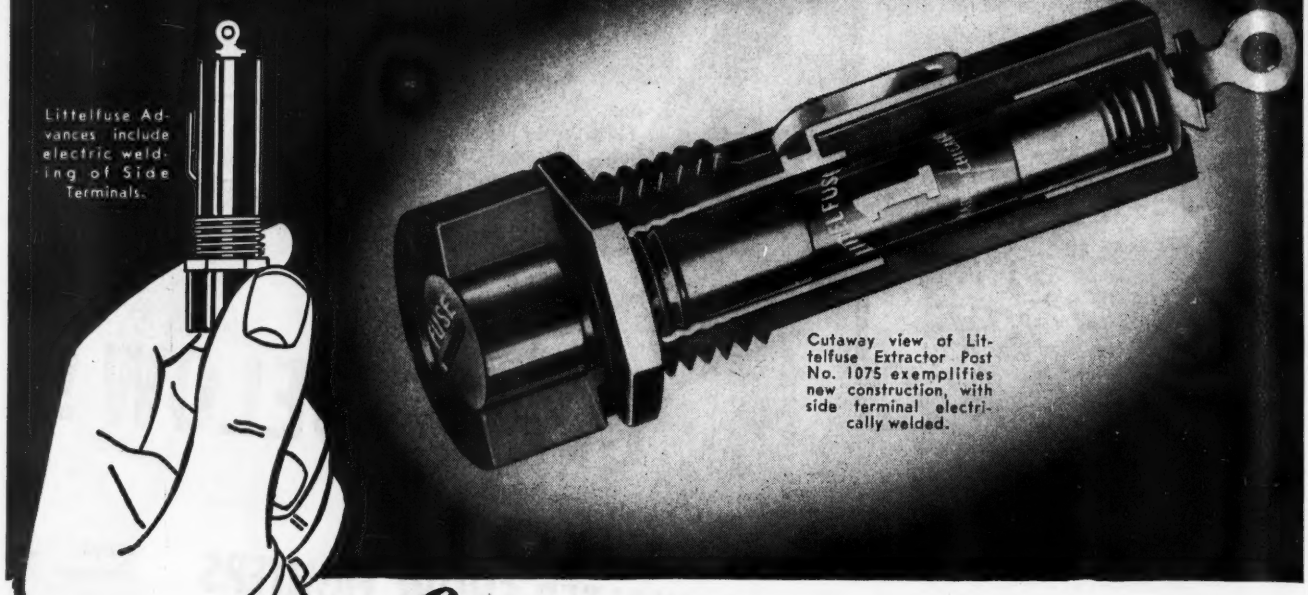
If you're not using Walter Snow Fighters —if your past winter's record can not match this kind of performance — start planning now for the next snow season.

Write today for complete information.

WALTER SNOW FIGHTERS

WALTER MOTOR TRUCK CO., 1001-19 IRVING AVE., RIDGEWOOD 27, QUEENS, L. I., N. Y.

New *Littelfuse* Protection


Littelfuse Advances include electric welding of Side Terminals.
Cutaway view of Littelfuse Extractor Post No. 1075 exemplifies new construction, with side terminal electrically welded.

Greater strength, safety ease of fuse removal and replacement, with

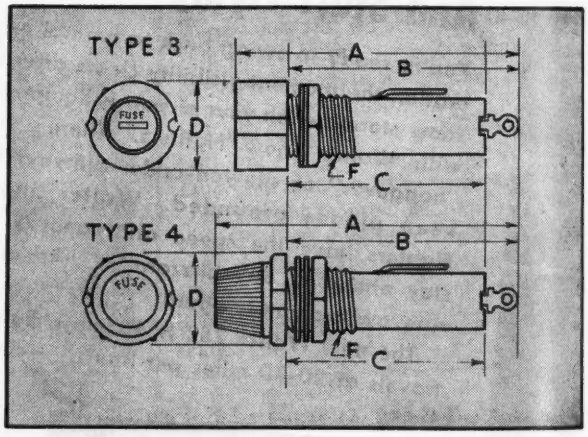
Littelfuse EXTRACTOR POSTS

Side terminals made integral with inside of shell by electric welding insure better conductivity and strength for added resistance to severe heat and vibration. Illustration and cutaway show strong body of molded black bakelite, insulating and preventing corrosion and shorts—positive Fuse Grip permitting full visual shock-proof inspection. Knob that pulls and *holds* fuse. Special Grip that prevents fuse from dropping out. Fuse can be taken from knob only by hand.

SEND FOR B/P AND ENGINEERING DATA

Ask for samples.

See how the *New* Littelfuse Extractor Posts are adapted to your product. Littelfuse makes fuses for every instrument use, silver-plated Beryllium Fuse Clips, Signalette non-shatterable signal indicators, Fuse Panels, etc. Write



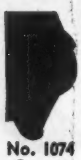
LITTELFUSE INCORPORATED

200 Ong St., El Monte, Calif. **4757 Ravenswood Ave., Chicago 40, Ill.**

Cat. No.	For Fuse	Type	Dia. Mtg. Hole	GENERAL DIMENSIONS A	B	C	D	Thread Size F	Wt. per C in Lbs.	Use with Fuses (Applications)
1075-S*	3 AG	3	17/32	2 1/2	2 1/8	1 23/32	23/32	1/2—24	3.27	Radios, auto radios, amplifiers, fractional h.p. motors, magnets, control circuits, relays, rectifiers, plate circuits, etc.
1075-F†	3 AG	4	17/32	2 19/32	3	1 23/32	23/32	1/2—24	3.13	
1087-S*	8 AG	3	17/32	2 1/2	2 1/8	1 23/32	23/32	1/2—24	3.34	Meters and delicate instruments, Radio "B" circuits, thermocouples, test equipment, small rectifier and power tubes, and for general instrument protection.
1087-F†	8 AG	4	17/32	2 19/32	3	1 23/32	23/32	1/2—24	3.2	

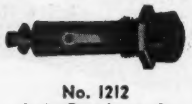
*Screw-driver operated. Underwriters' specifications. †Finger operated.

AIRCRAFT AND OTHER LITTELFUSE EXTRACTOR POST TYPES



No. 1074
8 A G attaches to meter binding posts, flat type multi range meters.

No. 1062
8 A G Fusible binding post for high class equipment. Essence of pearl knob.



No. 1212
4 A G Aircraft Screwdriver operated. Underwriters' Specification

No. 1212-B
4 A G Aircraft. Same as No. 1212 but with finger-operated knob.

No. 1212-C
4 A G Aircraft. Similar to mounting No. 1212, but Front-mounted.

No. 1245
Mounting for renewable Hi-Amp fuse links, 40 to 150 amps.

Explosion relief should be provided by a generous use of windows in exterior walls and doors.

The foregoing construction is suitable also for shops and stockrooms. Hangars, however, cannot readily be roofed with fireproof construction, for economical as well as engineering reasons. The use of incombustible materials, such as structural steel trusses and intermediate steel framing members with a masonry plank roof, is recommended.

All workrooms where spray booths or where fabric doping is done contain serious fire and explosion hazards. Vapor-proof and explosion-proof electric lighting fixtures, switches, receptacles, and motors are indicated in such areas, and non-sparking fan blades should be used on the ventilating fans in spray booths. In the hangar itself, all electrical installations that are located less than 4 ft. above floor level should be explosion proof.

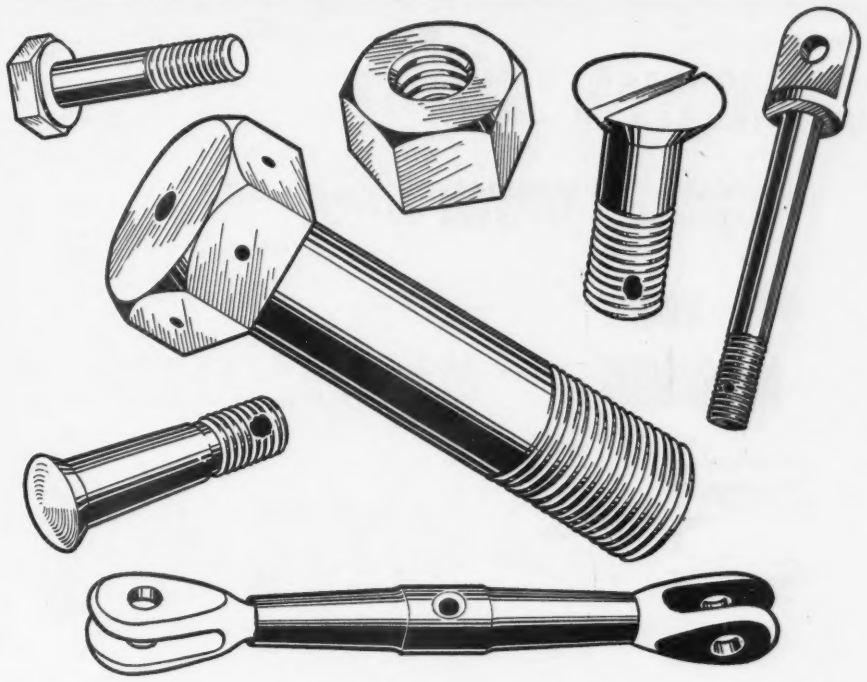
Fire Protection Equipment

Our considerations thus far have concerned planning of the structures themselves in relation to the uses to which they may be put. Next step is to plan the fire protection equipment that will become part of the structures or will be installed in them. All buildings require adequate standpipe and sprinkler installations. There is no special problem connected with standpipes, the conventional methods and regulations applying to overhaul and maintenance bases as they do to other industrial buildings.

The sprinkler systems in shops and stock rooms can be conventional wet pipe systems. In hangars, however, sprinklers become a special problem. The distance from the floor to the underside of the roof trusses in the average modern hangar varies from 35 to 40 ft. To this dimension must be added the distance from underside of the trusses to the underside of the roof, which may vary from 3 to 20 ft. This results in very high mounting heights for sprinkler heads, and conventional fusible heads are not practical for this purpose. Recommended is a system with heat actuated devices operating on the rate-of-rise principle.

Draft curtains, installed to subdivide the hangar area into sections of 10,000 to 15,000 sq. ft., are also recommended. These curtains consist of rigid non-combustible sheets extending from the underside of the roof to the lower chords of the roof trusses.

As important as the sprinkler system is the provision of an adequate number of the proper type of fire extinguishers and other fire-fighting equipment. Many more classes of fire risks are encountered at an airplane



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• Don't let a simple part hold up the production of vital planes. You can get them so easily and quickly from OHIO Aircraft Hardware Company.

Our stock includes a full range of eyebolt sizes—AN 42 through AN 49 inclusive, in all lengths.

We also manufacture the entire range of aircraft bolts, clevis pins and nuts, and can deliver turnbuckles in limited quantities.

All items are screw machine products.

QUICK DELIVERY!

For your urgent requirements most sizes are stocked—and we can give 15 day delivery on any size.

Before you file a Critical Shortage Report—Phone—Wire or Write us.

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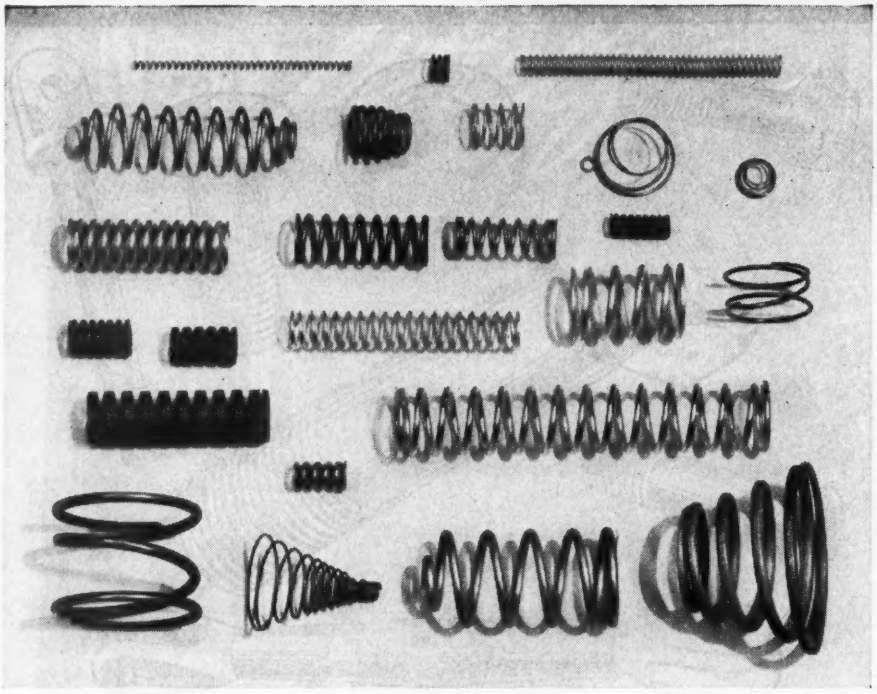

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SPRINGS *in Your Post-War* **PRODUCT**

Reliable

The springs which activate or cushion working parts in your product must be correctly designed. They must be accurate in size, perfectly formed, precisely heat-treated and tempered, carefully end-finished, inspected and tested. And finally, the cost item must be closely controlled.

We make all types of springs for all purposes—extension, compression, flat coil, tortion, also non-welded wire forms, flat steel stampings and spring clips. Our large stock of multi-purpose jigs and fixtures often reduces or eliminates your tool cost.

Here at Reliable, we have been trained in the stiff school of aircraft and armament parts production, to give you *something special* in engineering accuracy in springs. A high percentage of our output has *always* gone to serve the aircraft industry.

Let us quote on your drawings and specifications. Reliable engineers are at your service to assist in spring design.

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ROUND AND FLAT WIRE SPRINGS

CLIPS HOOKS BENDS LIGHT STAMPINGS

maintenance and overhaul plant than in a conventional factory. Furthermore, the presence of gasoline, lacquers, thinners, and other highly volatile liquids, demands that incipient blazes be extinguished immediately, otherwise large fires will result. Consequently, the provision of a large number of portable extinguishers, strategically located, is of utmost importance.

In hangars, the nature of the fire risks are such that many foam and carbon dioxide extinguishers are imperative. Water type extinguishers are of little use, except in stock rooms and offices. Should water be required in hangars, it would be needed in such quantities that only a standpipe or sprinkler system would be able to furnish a sufficient quantity.

Location of Extinguishers

The number of extinguishers required in a hanger can be approximated as follows:

For each 4,500 to 5,000 sq. ft. of floor area, provide a group of extinguishers consisting of one 2½-gal. foam extinguisher, one 10-lb. carbon dioxide extinguisher, and several small vaporizing liquid extinguishers. The 15-lb. carbon dioxide extinguishers have been found too heavy for quick use, especially in and around airplanes.

In addition, each hangar should be equipped with at least one 40-gal. foam cart and one 50-lb. wheeled carbon dioxide extinguisher.

In shops, fire extinguishers must be of the right type to fight the hazards involved. For example, the engine disassembly shop probably would contain some soaking or cleaning tanks filled with a flammable liquid. Foam extinguishers are best for such risks. Small spray booths may also be located in this shop for cleaning and spraying parts with light oil. A 1-qt. vaporizing liquid extinguisher ought to be attached to each spray booth. A few 10 or 15-lb. carbon dioxide extinguishers might be provided in the area.

In a room employed for testing carburetors, using a gasoline flow test, several vaporizing liquid and carbon dioxide extinguishers should be available. And about 25 percent of all work benches and stands in hangars and shops should be equipped with the vaporizing liquid extinguishers as protection against small electrical and miscellaneous fires.

A great deal has been said about crash trucks. They are necessary because airplane fires gain headway with such alarming rapidity that it is not practical to await the arrival of apparatus from the nearest fire house. Certain apparatus will be needed in a

ARNOLT PARTS
Serve on Planes, Ships and Amphibians . . . . .

In the tough task of silencing shore defenses and establishing beachheads from which to defeat the Axis, American-built planes, ships and amphibians are playing a vital role . . . . We here at Arnolt Motor Company are proud that precision parts, made in Arnolt plants are serving in many of these modern weapons. Because our diversified facilities have recently been increased, we can now serve a few more prime contractors who need additional production capacity.

If you need parts or complete units requiring extreme accuracy, write for our new booklet, "Available Facilities for the War Program."

Peacetime Builders of

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Back the Attack

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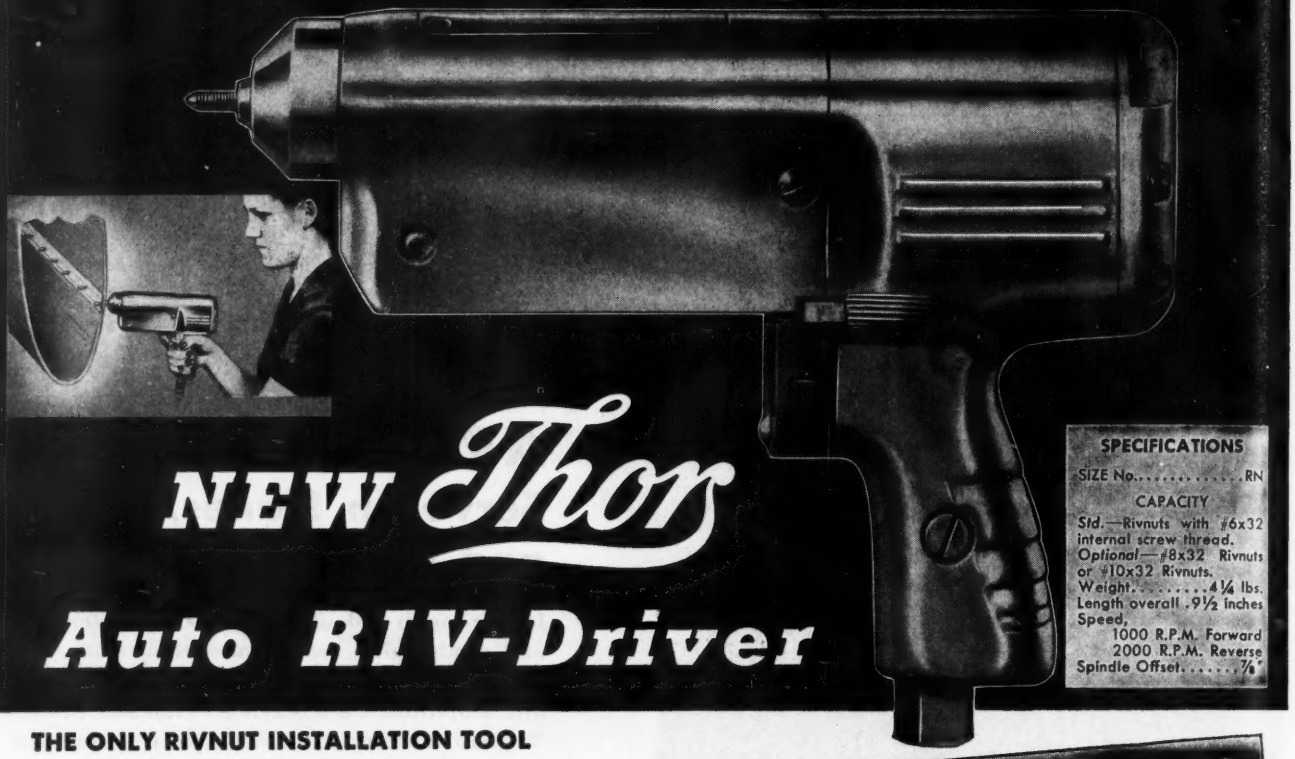
DRIVES RIVNUTS 6 TO 8 TIMES FASTER!



NEW Thor Auto RIV-Driver

SPECIFICATIONS

SIZE No. . . . . RN

CAPACITY

Std.—Rivnuts with #6x32 internal screw thread.
Optional—#8x32 Rivnuts or #10x32 Rivnuts.

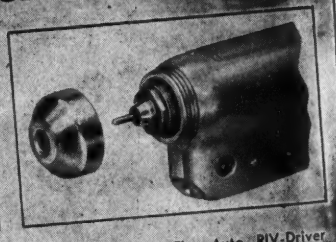
Weight. . . . . 4¼ lbs.
Length overall . 9½ inches
Speed,
1000 R.P.M. Forward
2000 R.P.M. Reverse
Spindle Offset. . . . . ⅞"

THE ONLY RIVNUT INSTALLATION TOOL THAT IS COMPLETELY AUTOMATIC, POSITIVE . . . FOOLPROOF

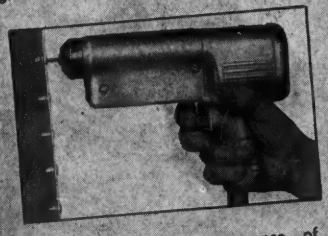
Here, at last, is the precision power tool that opens the way to new production records on assembly operations where the advantages of B. F. Goodrich RIVNUTS are utilized. With the Thor Auto RIV-Driver, the installation of Rivnuts is simple, fast and completely automatic. The tool does the entire job of running a threaded mandrel into the Rivnut, upsetting it, backing the mandrel out and stopping all action. The operator does nothing but press the throttle lever . . . makes no manual adjustments for any of the operations. Operating on a principle entirely new to portable power tools, the Thor Auto RIV-Driver makes Rivnut installation 6 to 8 times faster . . . and makes practical their use on scores of new applications.

LOOK AT THESE EXCLUSIVE FEATURES

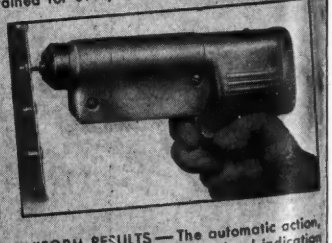
VISUAL INDICATOR—A light indicator on the handle of the Auto RIV-Driver lights up when the Rivnut is properly upset; does not light if Rivnut is incorrectly headed.



DEPTH CONTROL—The Auto RIV-Driver can be adjusted to upset Rivnuts at any depth required by the thickness of the metal. This precise depth of upset is maintained for every Rivnut.



OPERATING CYCLE—The sequence of operations in applying Rivnuts—running in, upsetting, backing out and stopping—is completely automatic with the Auto RIV-Driver. The order of the 4-cycle action, controlled by one throttle, cannot be affected by the operator.



UNIFORM RESULTS—The automatic action, positive depth control and visual indication of correct operation on the Auto RIV-Driver gives assurance that every Rivnut is driven properly and uniformly.

FOR FULL INFORMATION

Thor Bulletin No. 247 will give you detailed information on the new Auto RIV-Driver, including specifications, performance data, and construction features. Send for it today!

Thor *Portable Pneumatic and Electric Tools*

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Branches in Principal Cities

hurry if a plane crashes or if a fire of any consequence breaks out. For this reason, the crash truck should be equipped with apparatus and supplies for generating foam, considerable hose, large quantities of carbon dioxide, axes, tools, asbestos suits, rubber coats, boots, helmets, first aid equipment, and the like.

Such a truck will be useful in stringing hose from hydrants to the location of a plane fire anywhere on the airport as well as for its foam work. Range of the truck, however, will be limited by the location of hyrants. To overcome this, flush hydrants can be located along the runways, or a water tank truck with a pump can be provided to supplement the foam generators on the crash truck.

Private Fire Brigade

From all the foregoing, it is obvious that an airplane maintenance and overhaul base needs the protection of a well trained and organized fire brigade. Members of the fire brigade should be under the command of a competent chief, and their training should cover all points of protection and prevention. Instruction can be supplemented by actual tests and demonstrations of extinguishers, giving the members an opportunity to use the equipment on the different classes of fires. Only in this way can men become familiar with the proper operation of the extinguishers, and such training eliminates fumbling when seconds are precious.

All fire-fighting instruction and drilling will pay good dividends. However, they do have a tendency to make the employees feel self-sufficient and forget to call the public fire department. This failing can be overcome by the appointment of individuals, sometimes called "alarm box runners," whose duty it is to sound the public alarm and subsequently direct the firemen to the scene of the fire. A good proprietary alarm system is essential and all employees should know how to use it.

Equipment, tools, and machinery must be carefully selected and maintained. This can be assured by using equipment marked with the approval label of the Underwriters' Laboratories or Factory Mutual Laboratories.

Small gasoline-driven tractors used for towing and hauling airplanes should be equipped with protected ignition systems, special air intakes, and approved mufflers to eliminate exhaust of gasoline fumes and sparks. Portable electric tools need to be properly grounded, and special attention is required to prohibit the use of any but rugged vapor-proof portable lights. Heavy-duty extension cords are indicated in all cases.

How To Kick a Plane In The Pants

WHEN A PLANE'S "settin' " on the assembly line—when it's laid up for repairs—the only one it helps is the enemy. So it's your job to see that they're finished and flying—*fast.* And it's our job, too.

To help kick planes upstairs faster—to speed production—to aid maintenance and repair—you need special lifting equipment. That's where Sedgwick shines.

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So if your job is keeping planes in the air—if you want to get them there faster—if you're faced with the many lifting and hoisting problems these jobs entail, *let us know about them.* We offer complete design, engineering and manufacturing facilities to produce special lifting and hoisting equipment for aircraft manufacturers, military airfield and commercial airport operators.

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If all of these precautions are taken in planning the overhaul and maintenance base—and *if* they are properly carried out by the ground crews and executives—there will be little difficulty with fire. Experience has shown that adequate planning, good equipment, and trained men can overcome this bogey of base operation.

RCAF Prevents Waste

(*Continued from page* 169)

dozer, which inch by inch crept with it over the newly constructed road, on two occasions just missing tipping over the edge and hurtling down a cliff. Quick work by the soldiers and airmen averted the danger. Yes, it took a lot of work to salvage that aircraft—but it meant one more plane in the air.

Another time, a *Hudson* bomber which had landed on a mountainside in the Eastern Command area had its engines removed and was taken 3½ mi. down the mountain to a frozen lake in 19-below weather, and there had its engines refitted, after which it was able to take off from the ice under its own power. Also a *Canso* amphibian, with depth charges aboard, sank in water off the Newfoundland coast. With high seas to make the work more difficult, an RCAF rescue crew grappled for the aircraft and brought it up to the surface for salvage. They had to keep in mind those depth charges all the time they were at work. And an *Anson* bomber trainer landed on an ice floe off the Newfoundland coast. Its crew was rescued without too much difficulty, but salvaging the aircraft was another matter. Flyers kept that ice floe and its stranded *Anson* constantly in view. When the floe drifted close to shore, the aircraft was rescued from its icy landing field.

Salvage and reclamation of crashed aircraft is especially proving one of the best sources of supply, for those items which are scarce. There are three classes of crashes, "A," "B," and "C," the first being those craft beyond repair. Every crashed plane that is salvageable goes to a repair depot, of which there is one in each RCAF command. There they are gone over minutely by qualified engineers. All serviceable components are removed, examined by aeronautical inspectors, and put back into stock. Equipment is either repaired at the depot or, if beyond depot facilities, is sent to civilian contractors. Materials which cannot be re-incorporated into aircraft (such as forgings and central columns) are sold to the manufacturer of each type of aircraft through the Department of Munitions & Supply at the price set by the RCAF and the Department.

IN AIRCRAFT VISION for VICTORY

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LIBERTY AIRCRAFT MIRROR

The pilots of thousands of Allied fighter planes, now in action over our widely scattered battle fronts, are getting a perfect image of things behind them without eyestrain or fatigue, by means of Liberty Aircraft Mirrors.

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HERE YOU SEE a force that Hitler and Tojo sadly misjudged — *American womanpower.*

Day and night, throughout the U.S. aircraft industry, women by the thousands are working to upset the Axis applecart. Women who were stenographers, home-bodies, salespeople . . . the girl next door . . .

They multiply mightily our productive power. Make it possible for ever-growing swarms of warplanes to be turned out faster.

The airplanes built at Northrop carry a message from free men and women — in the only words the enemy seems to understand. And even as our planes speak in battle, the Northrop group works on — creating and building yet more deadly aircraft.

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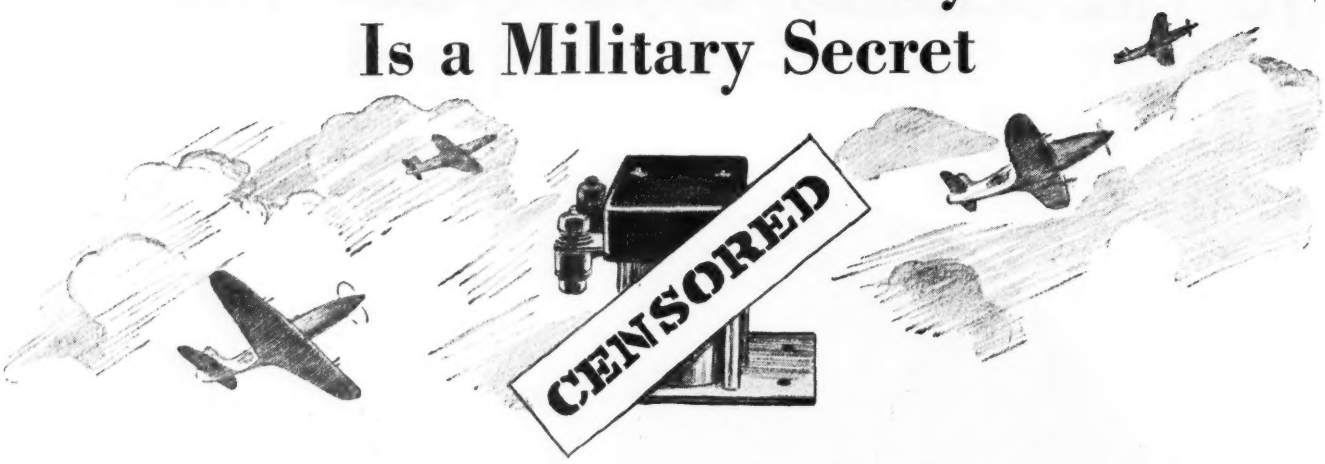
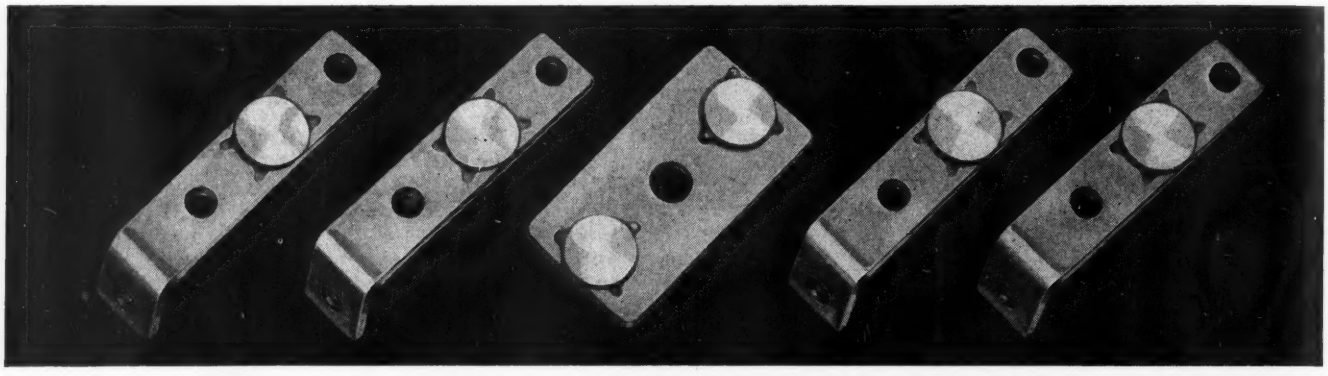


...But Here Are the Clues to Its Better Performance



In wartime, we can't mention names or tell the story in full. But the facts are not without significance, even with many details omitted.

One of the first types of aircraft relay to be accepted for military use was equipped with Mallory contacts. As planes improved, and greater performance was demanded, the relay needed further development. The manufacturer needed a better material—and, being pressed for delivery, he needed it fast.

Thanks to Mallory engineering research, it was possible to recommend a new material manufactured by an entirely new metallurgical process —Elkonite* G-12. When this was backed with Mallory 3 Metal, the improved specifications were met. Production was started without a moment's delay *because previous development had paved the way.*

Like the relay manufacturer of this story, many design engineers prefer to consult Mallory *first* —often while plans are still on the drawing board. They've learned that Mallory engineering saves time and money: that it frequently anticipates tomorrow's trends. Why not bring your next problem to these same engineers who, for over a period of twenty years, have earned for Mallory the name of "Contact Headquarters."

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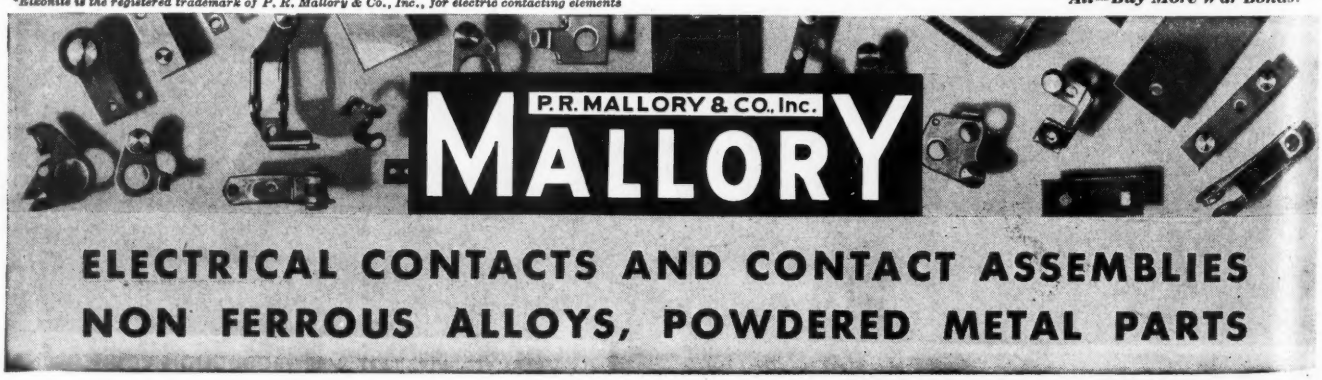


Salvage work is handled through the Air Member for Supply on the Canadian Air Council. On formation of the salvage section it was realized that if a maximum effort was to be obtained it was essential to engender a spirit of conservation among the personnel. This has been accomplished through the formation of voluntary patriotic salvage committees at all units, and the individual air force man is now highly salvage conscious.

Lists of items which are recommended for disposal, because they are considered surplus or are obsolete, go to headquarters at Ottawa, where they are passed on to various sections dealing with supply within the air force. Where equipment cannot be used within the force, disposal as equipment or scrap is handled for the RCAF by a salvage officer of the Treasury Board. Standing contracts have been arranged in all commands for the disposal of accumulations of scrap metals and other materials, such as kitchen waste, used oil, etc. Where no contracts exist, disposal of equipment and scrap is done through tenders. Primary aim of the salvage section is to assure maximum quantities of needed materials for hard-pressed industry to remanufacture in pursuance of Canada's war effort.

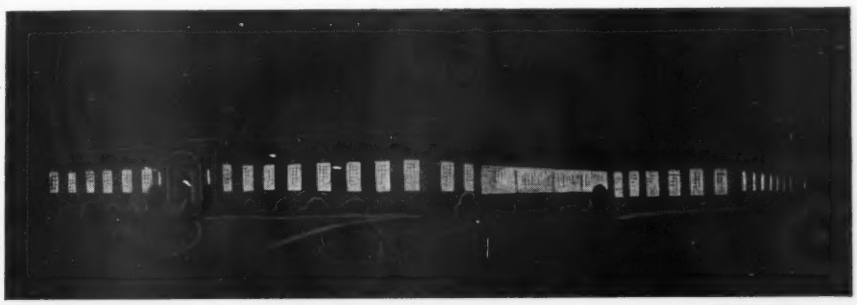
Detailed instructions have been issued to all commands as to handling each item of salvageable equipment. Thus, for instance, used oil is disposed of by sale under contract to the provisioning oil companies, except in western Canada, where the company supplying oil reclaims it, and the RCAF uses it once more in its motor transport section. Tests have indicated that reclaimed oil is not really satisfactory for re-use in airplane engines, although it has been used in this way in Great Britain by the RAF for some years.

All used ethylene glycol base anti-freeze is currently being sold after being salvaged, under government supervision as to its re-use. The Canadian Army is reclaiming anti-freeze used in motor transports for re-use.

There are hundreds of items which have a re-use value. Instructions on disposal of these fill hundreds of pages of administrative orders. A few picked at random show how thoroughly the RCAF has gone into the salvage problem. Instrument packing cases, as an example, must be held at each unit and reported quarterly. Surplus accumulations are returned periodically to manufacturers for re-use. Slinging irons, braces, angle irons, and corner irons from aircraft packing cases from Great Britain have to be saved and shipped back after the wooden packing cases are broken up. Unserviceable engines and airframe parts are sent to air cadet training squadrons.

Nose sections of practice bombs are salvaged and refitted with tails for re-use. Bombs dropped on land ranges in winter time may not penetrate the frozen ground, and the RCAF puts aside time on bombing practice ranges for airmen to go out and salvage this metal on certain days in the spring. All metal film cores and clips are to be salvaged and sent back to the manufacturer, who has agreed to a price of 1c. each for each item which can be re-used in the making of more aerial photographic film. Unserviceable aluminum propeller blades, minus all other metal, go in accumulations of at least 200 lb. to the aluminum manufacturers. Similarly, metal typewriter ribbon spools go back to the manufacturers.

So carefully has the RCAF gone into the salvage problem that even bent nails are accounted for in an instructional circular on re-use, or if no longer serviceable they are to be sold as scrap. Similarly all metal containers, those for food and paint especially, are handled as scrap, except that paint



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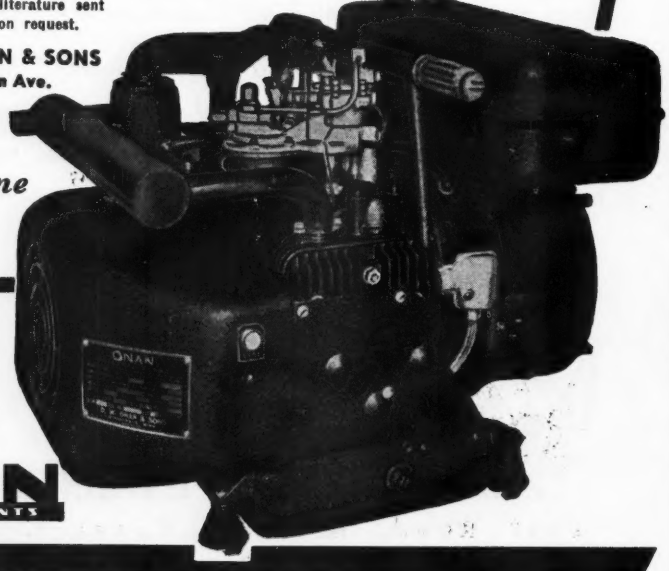

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containers of 1 gal. or larger size are to go back to the manufacturers at fixed prices and on a priority system. Instructions for the conservation of all types of wooden and paper containers are minute.

Aircraft going to contractors for overhaul are drained of oil and gasoline and an accounting of this salvaged fuel is kept, a similar amount being re-issued on completion of overhaul. Used oil drained from such aircraft is to be sold for subsequent reclamation purposes.

Conservation has been carried out on a large scale in the use of motor cars at the various commands, pooled operations by all sections now being standard to save gasoline, tires, and equipment. All rubber no longer serviceable is disposed of as scrap to meet the rubber shortage.

While at present the RCAF salvage operations are aimed at discarding nothing that can economically be re-employed, no detailed planning has been done as yet on postwar disposals of equipment. But the RCAF has made big strides in the salvaging and reclamation of equipment and has set up an organization well able to tackle postwar salvage when policy on that subject has been set.

Helmsmanship

(*Continued from page* 183)

rounded each desk) are checked at this time.

The "first avigator," Cadet John P. Frazier, 20, of Philadelphia, has the job of directing the pilot to the objective. His work is to be checked by the "second avigator," seated at the desk to his rear, Cadet Herbert J. Gotha, 22, of Paxton, Mass. "Third avigator," Cadet Edwin H. Harley, 22, of Canton, Ohio, follows the course on his maps, employing pilotage or avigation by the use of landmarks. Throughout the 4-hr. mission, the cadet trio is constantly busy under the surveillance of Lt. Strong.

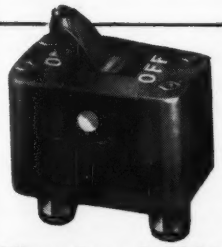
Cadet Frazier now begins plotting co-ordinates of departure and turn on his map as the C-60 roars over the starting point, a bridge near Monroe, La. The distance to the turning point —125 mi.—and thence to Clarksdale is totaled in nautical miles and a true course of 335 deg. is computed accordingly.

In order to figure ground speed, Cadet Frazier looks through the drift meter at his side, a "bombsight" sort of instrument which enables him to line up the longitudinal axis of the plane with points on the ground and thus determine the amount of drift in the ship's flight through the air. Two

KLIXON AIRCRAFT CIRCUIT PROTECTORS

Klixon PM-1" Circuit Protector. Ratings from 5-40 amps. in steps of 5. Weight, 1½ ounces.

Klixon PLM-1½" Circuit Protector. Ratings from 35 amps. through 150 amps. Compact and light in weight.



Klixon Type D-6364 Switch Type Circuit Breaker. Ratings from 35 amps. up. Fits in space required for two of type C-6363.

Klixon Type 6363 Switch Type Circuit Breaker. Ratings from 5-35 amps. in steps of 5. Small and light in weight.

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Klixon Indicating Push Button Type Breaker. Opens only by current overload. Ratings of 15-50 amperes available. "Shunting" switch makes unit "non-trip-free".

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KLIXON AIRCRAFT CIRCUIT BREAKERS

Klixon Aircraft Circuit Breakers help planes get home. If flak, enemy aircraft fire or internal troubles injure the electrical circuit and cause a short or overload, Klixon Breakers promptly trip-out thereby protecting the circuit. As soon as the trouble is corrected, the pilot simply pushes a button or throws a switch and the circuit is re-established. Harmless transient shorts do not affect Klixon Circuit Breakers, thus nuisance breaks are eliminated.

Give warbirds a chance to get back to the roost . . . use Klixon Circuit Breakers and Protectors on your planes. They're foolproof, light-weight, easy to install and are not affected by shock, vibration, altitude or temperature. Bulletins showing dimensions, ratings, and performance characteristics will be sent on request.

ARMY E NAVY

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Guided by the stars toward their "target for tonight" . . .

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DALTON DEAD RECKONING COMPUTER.
TYPE E-6B. Standard with Army and Navy Air Forces

"double drifts" are taken on each leg of the trip. Over the interphone system, Frazier tells the pilot to fly 45 deg. to the right for two minutes then 90 deg. to the left to get back in course.

During this interval which adds a minute to the "ETA" (estimated time of arrival), the hard-pressed cadet is busy both adjusting the drift meter and entering data on a log sheet before him. Wind force and direction—important factors in determining the true course of the plane—are computed from two different headings during the double drift. An average indicated airspeed is determined and corrected for instrument error, temperature, and altitude.

At 30 min. intervals, Cadet Frazier enters a position report on the paper before him, and every 5 min. he reads his chronometer, airspeed indicator, altimeter, temperature gage, periodic compass, and drift meter. In addition to the varied instruments mounted all around him, he is equipped with a Weems Aircraft Plotter, a pair of dividers, six pencils of varying hardness, an E6B Computer, a sextant, astronomical tables, a log book, Mercator chart, Lambert conformal sectionals, and a plotting arm attached to the front of his desk.

Meanwhile, Second Avigator Gotha is busy going through the same precision routine. And Third Avigator Harley constantly peers down, comparing rivers, roads, towns, railroads, and power lines with features on his map and, in addition, reads his instruments and checks entries on the logbook.

On the return trip, the three change positions and jobs. Gotha becomes first avigator, Harley is second, and Frazier moves to the rear for the pilotage assignment.

Landing home again at Selman Field the men are sweat-soaked and tired—but they're happy when Lt. Strong gives them the results of their trip: Cadet Frazier is ½ min. and 1 mi. off course on the upward trip to Clarksdale—an exceptionally good record; Cadet Gotha is 1 min. and 4 mi. off—better than average considering the strong winds; and Cadet Harley is "zero-zero", or right-on-the-button with his pilotage. Next day the three gather with Lt. Strong for a thorough critique where mathematical calculations are reworked and other techniques discussed and criticized.

The flight to Clarksville is but one of many that cadets take from Selman before winning their wings. There are others in which emphasis is placed on both day and night celestial avigation. Still others try the cadet's technique at using the radio as his aviga-

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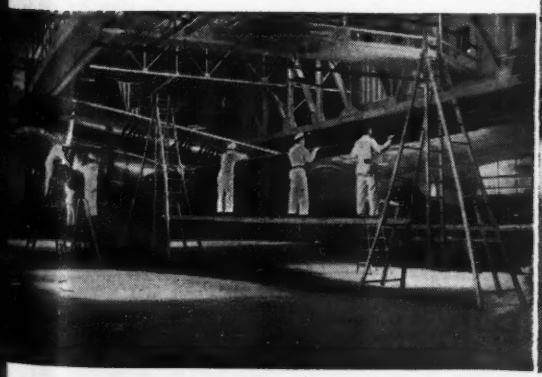

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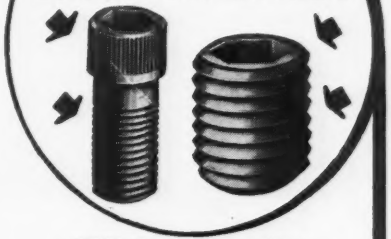

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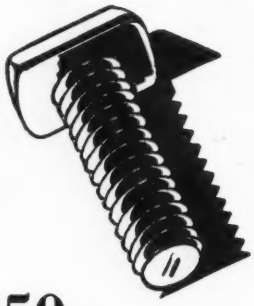

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tional aide. He also gains proficiency at the fourth avigational method, pilotage.

More than 100 hr. are spent by the cadet in "synthetic" training in which many ingenious teaching methods are utilized. He studies maintenance and the operation of various types of octants and sextants in a special "laboratory." In a miniature groundbound plane known as an "avitrainer," which is similar in many respects to the better-known Link trainer for pilot instruction, he gets the sensation of movement while he avigates against artificially-created winds and drift movements. Directional radio equipment has been installed in another classroom, while still another introduces the cadet to the astrograph, a device which projects astronomical locations on the map or chart being used by the flying navigator.

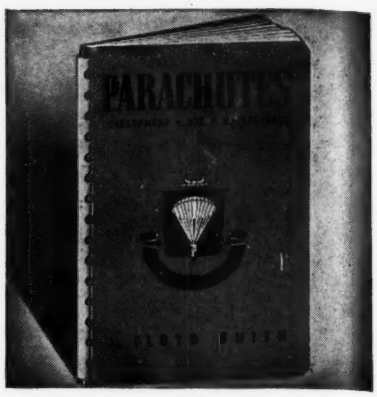
Throughout the course, every effort is made to create in the cadet a sense of his own close relationship to combat. His training flights are "bombing missions" in which he keeps rendezvous in the skies with others of his side, and his classroom activities, like that in "Grope," are charged with the vitality of lessons that are learned in action and are transmitted to the home front for incorporation in his training curricula.

Closely tied in with this training program is that of the AAF utility man—the aerial observer. He knows the most about the greatest number of airjobs to be done. His course of training is designed to produce an all-around flyer who is photographer, photo interpreter, map-maker, artillery fire director, radio and communications man, camouflage detector, navigator, machine gunner and, on occasion, pilot or bombardier.

At Brooks Field, Tex., the AAF Flying Training Command is attending to the production of thousands of new "sky reporters" for front-line combat units. Because this training program calls for unusual soundness of mind and body and an ability to grasp quickly a great number of duties, the observers are carefully selected from graduates of commissioned officer candidate schools. A large percentage of the student officers come from the Infantry, Artillery, or Armored Force and, after a year with the Air Forces, they return to their particular branches of the service.

Emphasis at Brooks is placed on proficiency in aerial photography. Under the guidance of experts, students spend 8 hr. in class absorbing the theory of exposure, camera operation, and the principles of military picture-taking before ever getting into a plane.

"Although the aerial camera is a



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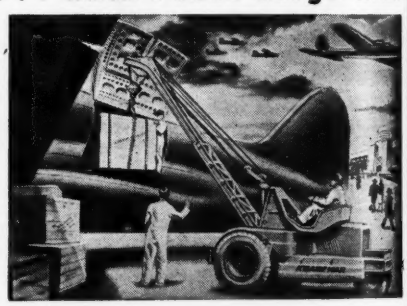

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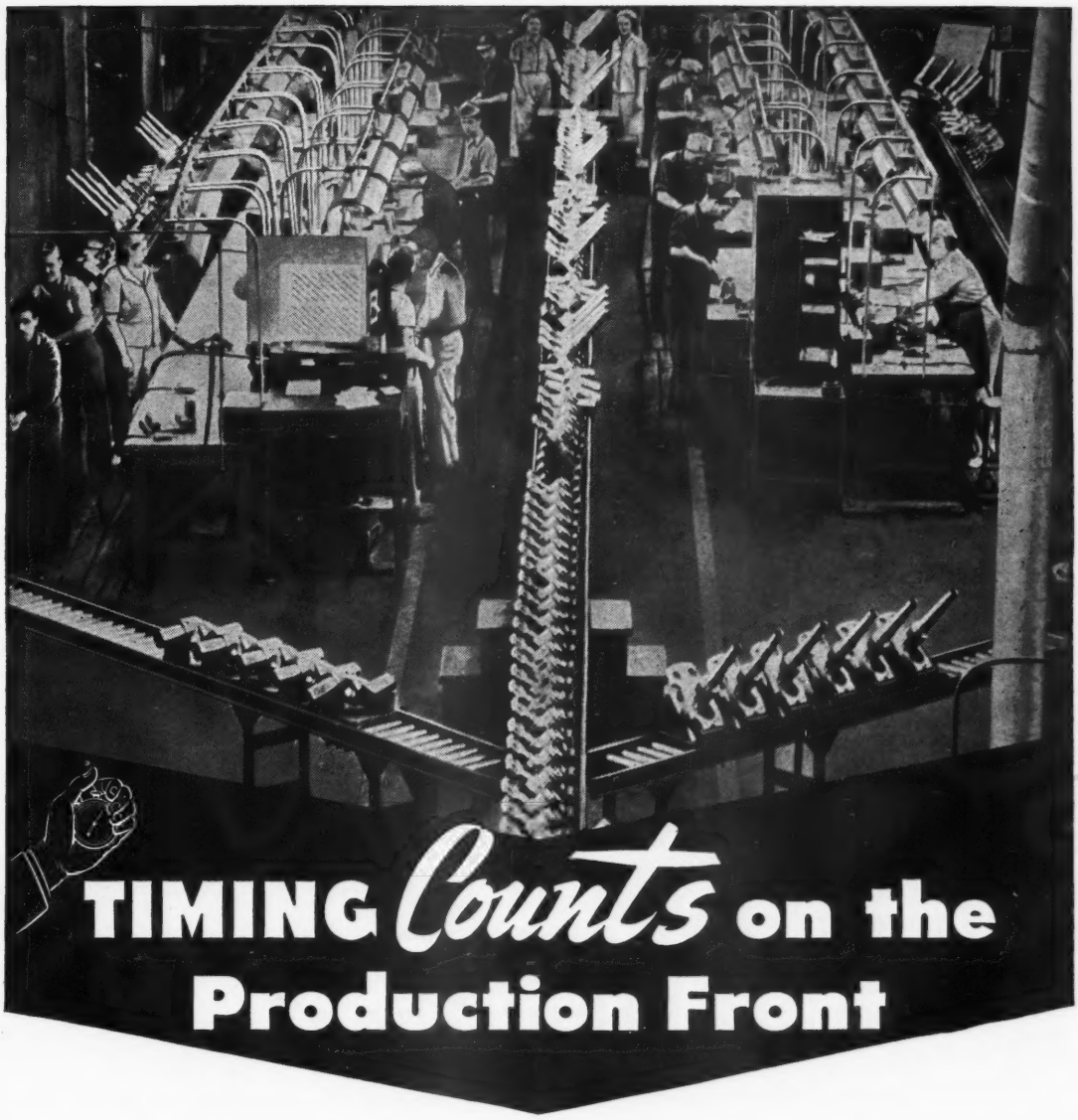

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big and rather complex-looking device, its actual operation is closely related to the inexpensive 'Brownies'," students are told by Capt. T. E. Bercaw, youthful photographic officer of the school. To prove his point, he introduces classes to operation of the Army's C-1 and C-3 cameras, similar to those used by newspapermen. Pictures are taken on the ground, and classes are taught printing, finishing, and mosaic laying. Ground photography then is tied in with the air assignment, and the student finally sees his actual combat-type equipment.

The K3B is a 50-lb. camera with three lens cones controlling the focal length so that the same scale may be attained at varying altitudes from the earth's surface. A newer version, the K-17, has a faster shutter speed and larger magazines but the same variable focal length. Smaller, more mobile models, such as the K-20, are also in use. Although today's war-cameras are basically the same as those used in 1918, improvements such as interchangeability of parts, increased shutter speeds, and filters make the AAF's present photographic equipment the best in the world.

Camouflage detection has been revolutionized by infra-red photography and by a Kodacolor process which permits selection of filters to differentiate the various phases of the color spectrum. If an observer expects green camouflage he selects the filter which will best show up unnatural shades of green.

Students fly approximately 20 hr. of aerial photo missions. One mission may find them taking "pin points," or direct views, of terrain, also various angle shots for making a third dimensional print. Another mission will find them "shooting" obliques. After each training mission, the film is quickly developed in Brooks' large photo laboratory and criticized later for both tactical and technical inaccuracies. In a single day's time, the photo lab develops an average of 6,000 8x10 student-taken prints.

Training missions are carried out in the 0-46, the 0-47, or the 0-52, all "pot-bellied" slow-moving ships with a maximum amount of room for observing and photographing through the bottom of the plane, or over the side. In combat zones, however, the slow-poking observation ship has been supplanted by the Army's fastest planes. Both the two-place P-38 and the P-39 with its trigger-controlled camera are now playing effective observation and reconnaissance roles, as well as the B-25, B-26, and the A-20.

In ground school, the Brooks' trainee is taught radio sending and receiving and the interpretation of panel messages, which are decoded from rectan-

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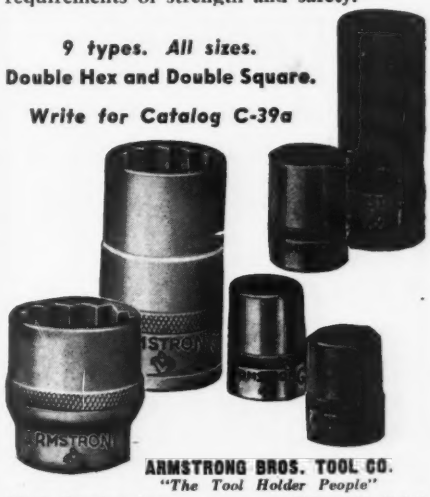

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gular pieces of canvas displayed on the ground during periods of radio silence. The panel, in favorable weather, can be read from as high as 10,000 ft. The cadet also gets a thorough course in aircraft and naval vessel identification and learns that various formations are designed for particular tactical purposes and that the mission of an enemy group may be determined from the order in which its elements may be flying or sailing.

Map making and the interpretation of maps is another important part of the observer's tarining. He also must know how to make sketches for imparting vital data to ground forces when maps or photographs are not available.

To ready him for the moment when his decisions and alertness may mean the difference between success and failure on a fighting front, the observer is given numerous tactical problems. In cooperation with ground forces in the San Antonio area, the aerial reporter gets a chance to scan actual infantry maneuvers and artillery fire on the range. To give him an opportunity to direct simulated artillery fire, the school initiated a "puff range" where pre-determined patterns of powder charges are exploded on the ground by an electrical control system. The observer, from his vantage point in a plane above, radios down the results to the "artillery commander," giving the direction and type of fire observed and instructions for silencing the enemy guns.

In the miniature bombing range at nearby Kelly Field, students solve most of the problems involved in directing artillery fire. Classes are seated around the railing of a circular "balcony" inside the silo-like range building. The floor, 100-ft. below, is painted to represent a portion of the earth's surface and is covered with hundreds of tiny concealed lights which flash artillery fire when switched on.

The problem to be studied on the miniature battlefield is outlined by text and instructor. One of the student observers then gives fire directions to the instructor and assistants at the control panel via his telegraph key, and the dot-dashes are amplified for the entire class. From these directions, the proper lights are flashed on the floor and results are recorded and criticized.

After finishing his day-night grind at Brooks, the observer is sent to the flexible gunnery school at Harlingen, Tex., for a complete training course. Along with the enlisted student gunners, he here learns the principles of firing .30- and .50-cal. machine guns,

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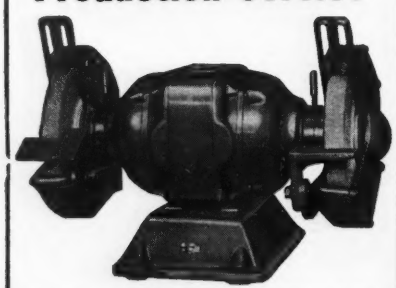

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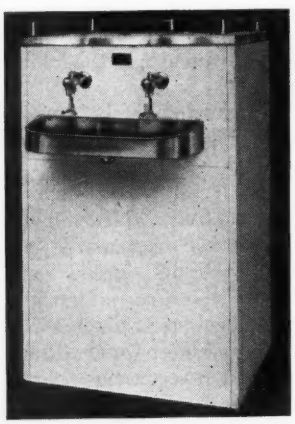

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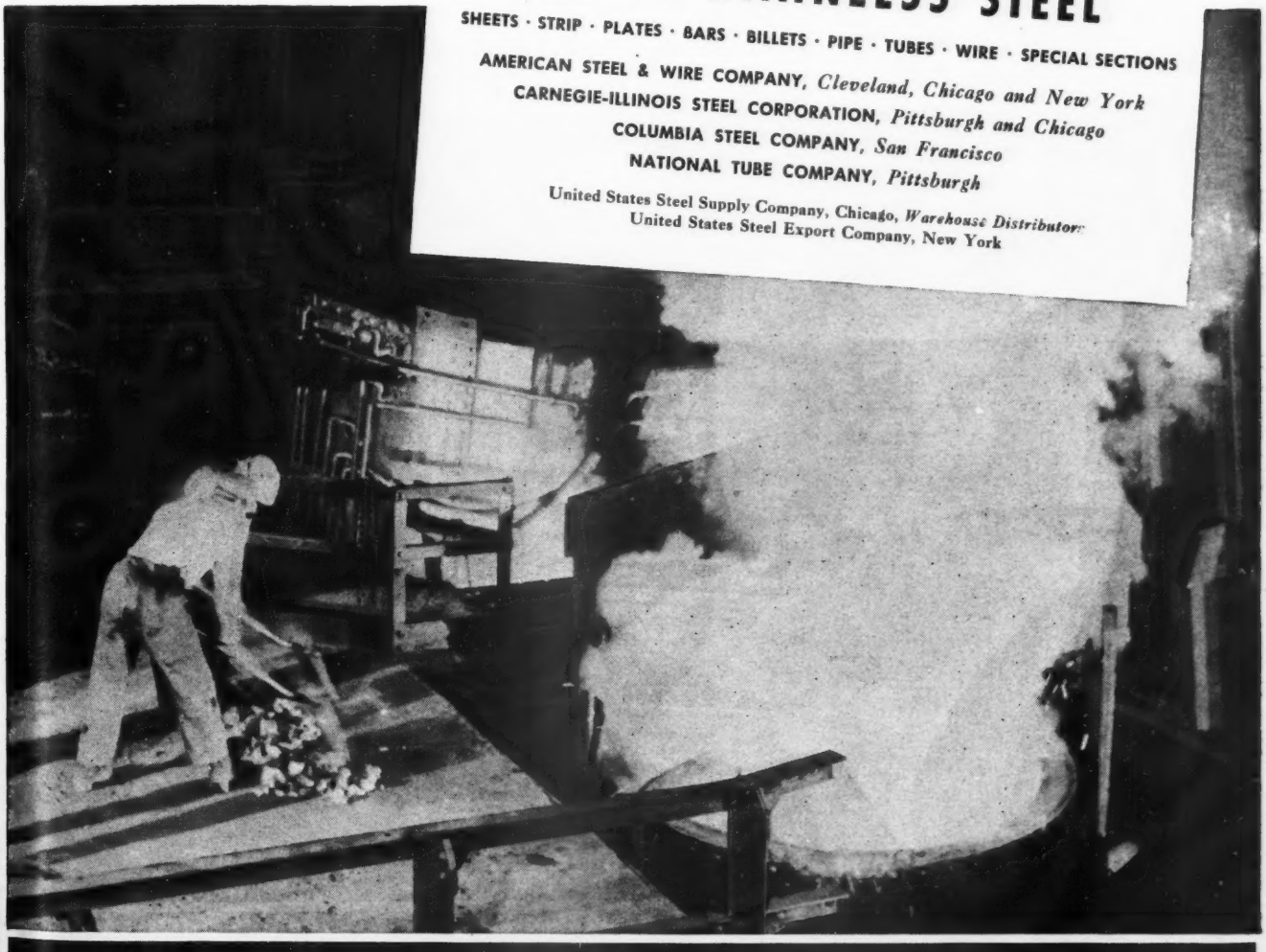

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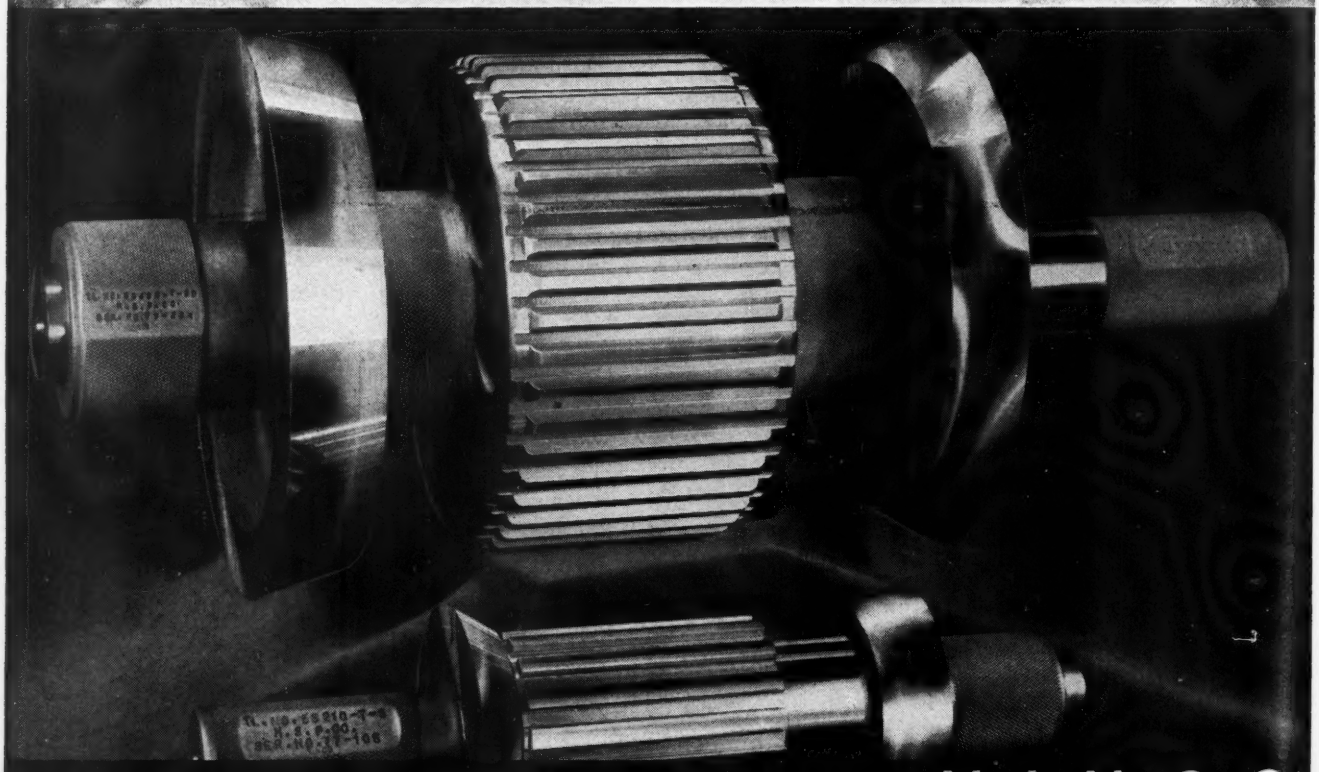

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both aground and in turrets above.

Although the observer's mission is getting the most information with least enemy contact, he must be prepared for battle. A typical trip over Axisland will find him busy making radio check-ins with headquarters, following a flight plan to check on estimated time of arrival at the objective to be photographed or observed, operating cameras, and keeping a record of time of exposure and shutter speeds, preparing a sketch, avigating the pilot home, and possibly warming his machine gun on a Messerschmitt or *Zero*.

The best observer in the Air Forces would be a time-waster if he lacked the knack of describing and illustrating to those who sent him out the results of his aerial scouting. He must be able to out-smart a clever enemy who rigs up ingenious and deceptive camouflage. Although he is rarely publicized, this keen-eyed Jack of All Trades is the man who is always there to observe and report. His are the eyes of a mighty army.

Celestial Avigation

(*Continued from page* 177)

It should be remembered that

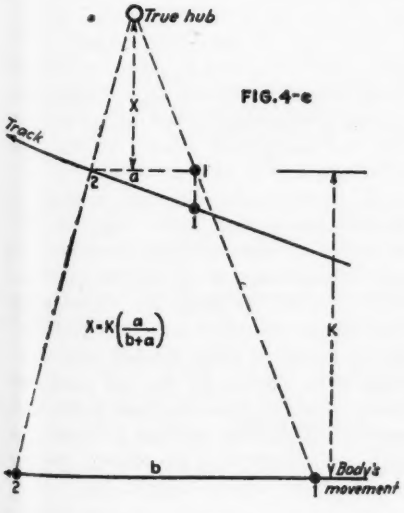
$$X = K\left(\frac{a}{b+a}\right)$$

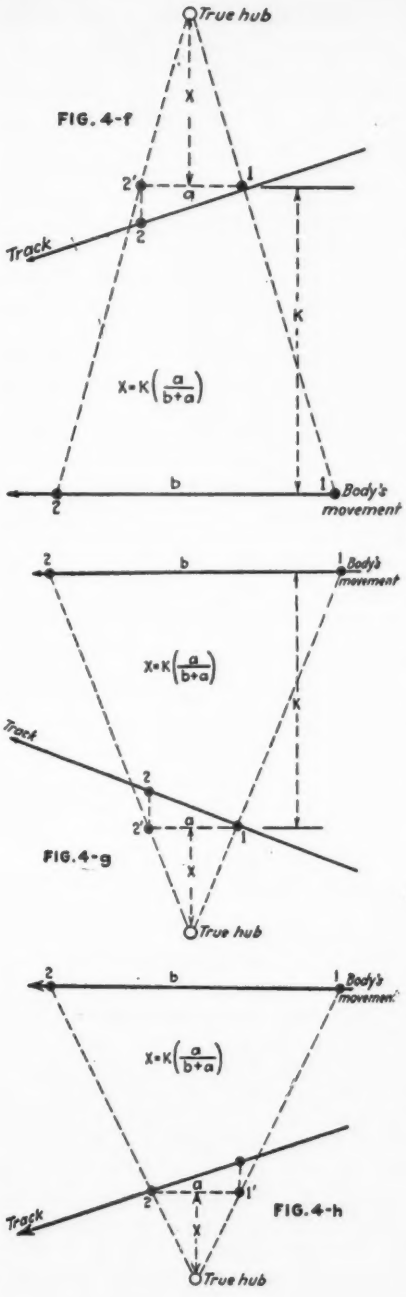
when the track has an easterly component, and

$$X = K\left(\frac{a}{b-a}\right)$$

when the track has a westerly component. The eight possible constructions given in Figs. 4a to 4h cover all possible cases.

In summary: First determine the meridian line, *M-M*. On *M-M* locate the true hub, found either by the construction on the body's declination line, or by computing the value, *X*. Once the true hub is obtained, determine points *O* and *N*, as already explained in Fig. 1. Use HO-214 tables to find when the celestial body is on the track.





Battlefront Air Bases

(*Continued from page* 181)

Before he departs for the contemplated base, the Navy engineer will pore over every report, map, or other information which can possibly contribute to the success of his mission. But usually such sources are limited, since engineering data dealing with the pin-speck island which will be his destination probably is sparse and unenlightening. The peacetime needs for which such available data was gathered are far removed from this wartime assignment. And the original survey, in all likelihood made years ago, hence can no longer be relied upon.

So, together with an aeronautical officer, who will pass on the proposed airfield sites from a military and tactical standpoint, the air base trailblazer takes off for his own personal aerial survey. If the island is unoccupied by enemy troops, the trip may be uneventful; if the proposed base is being used by the Japs, the party may have to fight their way back.

Should the island be occupied only by civilians or natives, now rarely the case, the officers may land, carefully appraise the sites under consideration, and at the same time secure any available local maps or photographs. More likely, the party either will have to content itself with what it can see from the air or from the data it can gather during a quick behind-the-lines excursion ashore. Two Civil Engineer Corps officers recently were awarded the Silver Star medal for their heroism under fire while participating in one of these surveys on a Jap-held island.

When the party returns to its operating base, the engineers will work from their on-the-scene observations and from the aerial photographs they have taken.

In the short space of time they remain on the island, they must line up the possibilities for runways and the many airfield necessities which are an essential part of a base for attack. They must consider plane dispersal area, ammunition and fuel storage, personnel shelters, and housing. They also must be on the alert for opportunities for camouflage, concealment, and protection of facilities.

Filling the Needs

Primary requirement for an advance-base airfield is an area suitable for landings and takeoffs. Tactical requirements may vary. A quickly built landing strip of grass, steel mat, or stabilized soil, supported by a minimum of ground facilities and intended only for temporary use by light aircraft, may be all that is called for. Or the need may be for a number of finished runways for prolonged all-weather use by heavy bombers, backed by all the facilities required for maintenance, administration, supply, and repair of the planes.

The site itself must be accessible by several routes so that it can be kept open in case of attack. Its precise shape is generally secondary. The runway locations will not resemble the conventional pattern of a commercial airport. This new field on Island X will be spread, instead, over an irregular area, chosen and laid out for maximum concealment and for the

opportunities it provides for quick dispersal of planes. Runways will not intersect—a stick of Jap bombs landing flush on one runway will have no chance of blocking another at the same time.

In planning Island X's airfield, the Civil Engineer Corps officer will require at least 3,500 ft. length for a runway designed for ordinary combat planes. If heavy bombers are going to be based on the island, he will have to step up the length to 5,000 ft. These estimates are made for normal sea levels. For each 1,000 ft. of elevation above sea level, the length of the runway will be increased anywhere from 250 to 500 ft. If the planes are going to take off singly, the surface width will be from 100 to 150 ft.; if they are to take off in formation, 500 ft. or more will be required. An additional marginal strip of 100 to 150 ft. is commonly provided on each side of the runway so that disabled planes can be dragged off.

If it is at all possible to land, the surveying engineering officer will investigate soil conditions on Island X. He will determine the surface and subsurface drainage characteristics; the land's condition and supporting power in both wet and dry weather; and its suitability as a foundation for either a steel mat or prepared surface. While on the island he will also check the variety and availability of raw materials, such as lumber, coral, or rock. He will also determine whether it is within hauling distance or already at the site. The water supply also will be considered, not only for construction, but for "wetting down" of the field, general maintenance, and for decontamination in the event of gas attack.

Probably this is as much information as the surveying party will be able to get on this reconnaissance flight. Indeed, it will consider itself fortunate if it can secure most of this data. In the meantime, veteran pilots will be flight-testing the areas around the tentative sites for hazardous local air eddies and currents. They also will look for ground haze and judge its effect upon visibility.

As the preliminary data is gathered, and Civil Engineer Corps officers at the operations base pore over their plans, another major factor remains to be taken into account: Since airbases are primary objects of attack, the Seabees must have ready effective measures for dispersal, concealment, and camouflage. Conspicuous landmarks, such as a bend in the river or the mouth of a stream, must be avoided, for they are "give-aways" that cannot be hidden.

The C.E.C. officers and Seabee camouflage specialists look for terrain containing a variety of texture and coloring, preferably an area which includes woods, brush, and grassland. Large wooded areas afford excellent opportunities for concealment from enemy observation. On the other hand, small patches of wood call attention to themselves and are quick to draw enemy fire.

Sections between mountain ranges are peculiarly adaptable for runway locations because they are difficult to spot from the air. Runways on beach and desert areas also lend themselves well to concealment. If the runways are situated close to rock outcroppings, hills, gullies, or woods, the natural cover can be used to conceal aviation repair and maintenance shops, storage tanks, explosive magazines, and similar facilities.

The Navy engineer must plan to protect and leave in their natural state all trees and vegetation that do not interfere with construction. Like a coach handing out assignments to his squad, the officer plans to have his Seabees use their heavy bulldozers to clear the underbrush and small trees, their stump pullers to take out average size trees, their mowers to cut dense tropical grasses, and their stores of dynamite or TNT to blast out large stumps.

Moreover, this officer must see that once the Naval Construction Battalion lands and sets up shop, newly unloaded material will not be piled up so that it is visible to enemy aerial observers. And he must make sure his men avoid destruction of ground cover so that no unnatural or tell-tale marks will remain after the material is removed. When natural cover is not available, he will plan to have nets thrown over piles of goods to reduce their conspicuousness. Or, if other means are lacking, he will see that the Seabees smear the material with ordinary garden-variety mud.

Satellite Fields

Ordinarily, however, a Seabee battalion's No. 1 priority will be to get at least a portion of a runway into shape for use by fighter planes at the earliest possible moment. Sometimes the battalion will begin work on a satellite field—which has no advantages other than speed of construction—before starting on the main field, so that as quickly as possible Allied fighters will be able to operate against the enemy bombers coming over.

That this careful planning and practical thinking has its reward is evident from the remarkable record which the Civil Engineer Corps and the Seabee construction men have established from the earliest days of the war.

One of the first Seabee battalions landed on the South Pacific island of Efate in May 1942. Marine aviation engineers had started a small field on the first of the month. The Seabees took over on the 15th—and in just 13 days, the first Marine fighter planes were able to land. In another month heavy bombers were using the field regularly. This job was done while the Seabees lived in hastily constructed tents and "dined" on iron rations for weeks at a stretch.

Too Hot to Handle

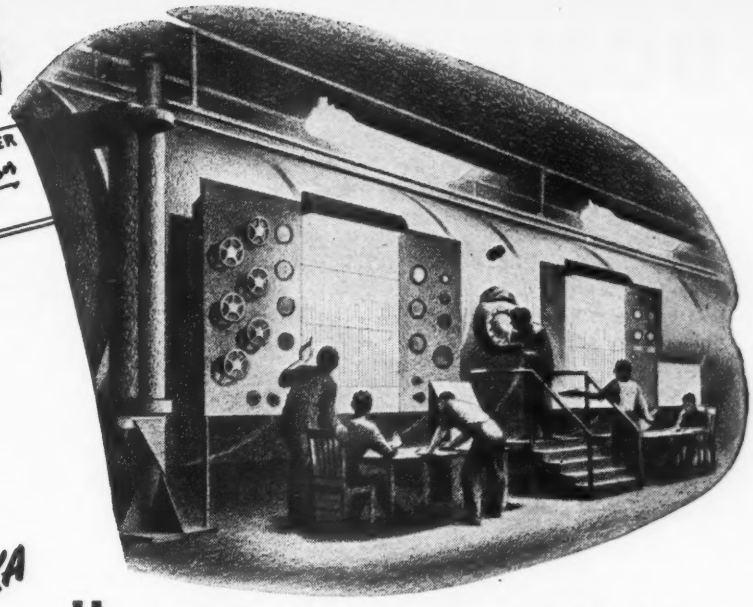
The same group of Seabees moved on quickly to Espiritu Santo, a neighboring island, and went to work on an airfield there. Tropical weather, which included rain every day for two months and, on the "clear" days, a hot and humid mugginess which took a heavy toll of the men's staying powers, never broke their spirit. Some of the time, it was so hot that it was impossible to handle any steel which had been standing out-of-doors for more than a few minutes.

Many of the airfields the Seabees have built in the Pacific have surfaces of steel matting, now often called the Marston Mat, after its first field use at Marston, N. C. But the fields at Efate and Espiritu Santo had to be completed without this ready-made surfacing. Shipping conditions at the time made it impossible to get the mats to the islands.

The resourceful naval engineers knew that both Efate and Espiritu Santo, like many Pacific islands, were almost entirely coral in composition. At the sites selected for the fields, their draglines went to work scraping the islands' surface. In some places as much as 2 ft. of humus was taken up before the coral foundation was reached.

Finally the space was cleared and the coral itself graded and wetted down, then tested as a surface. For emergency use, it proved a tremendous success, acting like a well-graded sand-clay surfacing material and absorbing water extremely well. While it was apparent that it would not stand up under continuous use by heavy bombers, the native coral surfacing was perfectly suitable for fighter planes and was used until a more permanent surfacing could be laid down.

At present, the general procedure in building a field calls first for excavation of the surface humus. It may be necessary to dig anywhere from 6 in. to 4 ft. to reach the underlying foundation of native coral. The foundation coral is then graded and covered with about 12 in. of dredged coral, which in turn is rolled down and graded. This new surface is hardened with sprinklers using sea water. (When tested, fresh water didn't seal satis-

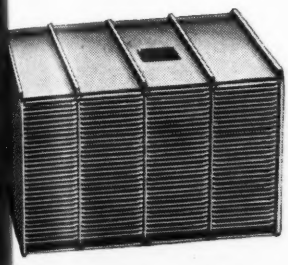


Here is the largest vacuum chamber of its kind... where weather conditions of *any part of the globe* can be duplicated . . . temperature brought below —90° F. ...and air made eight times thinner than on earth!

This is the AiResearch "Stratolab." Inside its air-tight walls many flying problems are solved *before* our fighting aircraft leave the ground.

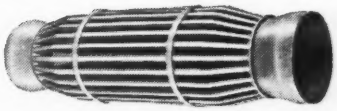
Ways are found to control high-altitude pressures and temperatures – to improve aircraft performance and crew comfort. And here equipment is constantly being developed to make our American warplanes superior in all climates and at all altitudes.

Many of these projects are restricted, but already well-known are these four—

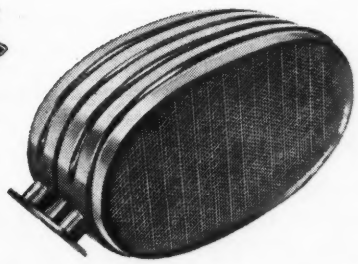


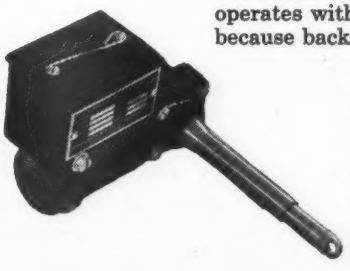
TYPICAL DEVELOPMENTS OF AIRESEARCH LABORATORIES

LIGHTWEIGHT INTERCOOLERS. AiResearch produced the first all-aluminum units which cut weight as much as 60%...pioneered use of the flattened tubes — saving space and providing greater heat dissipation.



EXHAUST HEAT EXCHANGERS. The AiResearch unit provides both cabin heating and flame-damping — *without auxiliary equipment.* Weighs little and operates with practically no drain on engine power because back pressure is nominal.





AUTOMATIC EXIT FLAP CONTROLS. Still another AiResearch "first," this system frees pilots from considerable instrument watching. It cuts open-flap time, reduces cooling drag, often adds 10 to 20 miles per hour speed. And it gives extra protection to engines operating at high altitudes.

IMPROVED OIL COOLERS. From AiResearch ...signing came greater ruggedness, increased ...ling efficiency... the first, space-saving el...tical shape coolers... a new principle of ...rge-protection." And, recently, *an oil cooler ...t can't congeal!*

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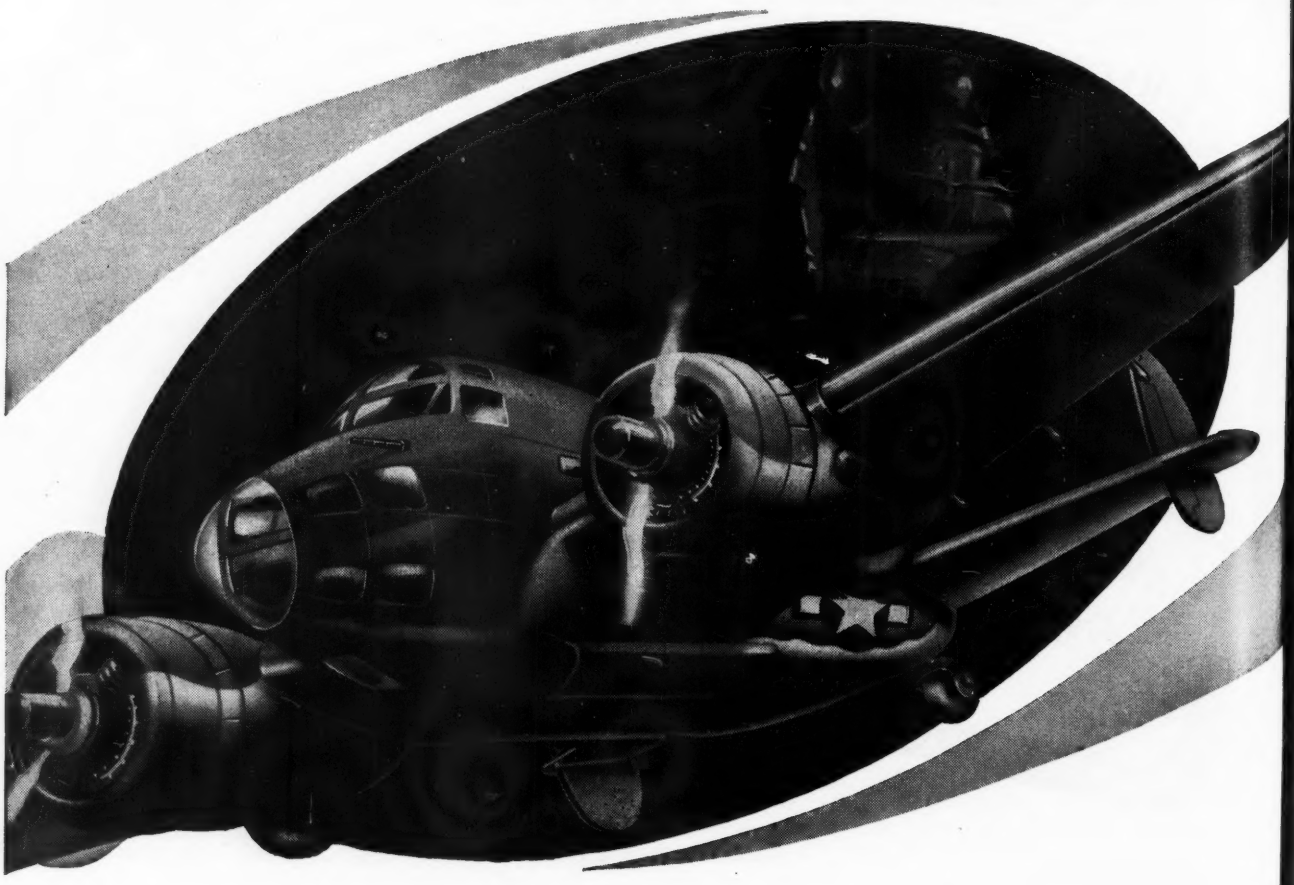

BACK of the tremendous striking power displayed by the Army Air Forces on every fighting front is a story of tools. Tools for production — for original equipment — for maintenance and service in every section of the world.

For without properly designed, well-made tools America's Fighting Planes would never have been built—could never receive the thorough servicing and maintenance of the highly skilled ground crews.

BONNEY TOOLS have played no small part in helping to meet the hand tool needs of the aircraft industry—manufacturers and workers—and the ground crews of the Air Forces. Pioneers of mechanics' hand tools for the aircraft industry, BONNEY TOOLS are on the production lines of leading aircraft and aircraft equipment factories—in the individual tool kits of uncounted thousands of aircraft workers. For years they have been and still are standard, original equipment for every one of tens of thousands of engines shipped by leading aircraft engine manufacturers.

Proved on the testing ground of time—their quality has earned them the reputation "the finest that money can buy".

If you have a troublesome tool problem for production or equipment—BONNEY TOOLS may be the answer.

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factorily.) Wherever possible, a 4-in. water main is laid on either side of the field. Coral surfacings tend to be dusty, but daily sprinklings overcome this disadvantage to a considerable extent.

The practice of laying steel mats as a foundation, then covering them with dredged coral, was an early measure which has since been discontinued. A native surfacing material which still is sometimes used instead of coral is scoria, a volcanic ash found on some of the islands.

The Civil Engineer Corps and the Seabees are basically behind-the-scenes organizations. Where our airmen score a smashing victory, the pilots, bombardiers, and gunners draw the lion's share of the cheers. But a few spectators also doff their hats to the officers and men of the Naval Construction Battalions. They are the "insiders"—the professional military men who realize more than anyone else that the fleet and the air arm are only as strong as their bases, and that these gallant, unsung fighter-builders are the ones who are carrying the burden of their construction.

Hydraulics Axiom

(*Continued from page* 158)

material handling: second, clean assembly; third, careful installation; and fourth, adequate filtration of oil both when introduced into the airplane and during operation. Entailed is an intensive educational program sponsored by the manufacturers.

The subject of filtration is too long to discuss here and is, therefore, being covered in another article. However, it must be pointed out that the only adequate type is "micronic filtration." Great credit must be given to the Purolator Products Co. for its development of this type filter. Credit must also be accorded Skinner Products, Commercial Filters, Cuno Engineering, Ertel, and Fram, all of whom have been working on this problem, developing various units and contributing largely to the solution of micronic filtration problems through their cooperation with the military services.

Expression of the degree of filtration in microns is new. A micron is one millionth part of a meter or .00003937 in. Thus, 10 microns, which is the largest size of particles allowed to pass through a micronic filter, is .0004 in. But this type filtration refers to two dimensions, and flakes and scale which can pass through plate or wire type elements now used in aircraft (Fig. 3) are completely blocked out. Even the third dimension, that of length, has limitations, since matter will be caught in the filtering element. (See Figs. 4 and 5.)

Another basic cause for hydraulic troubles is leakage. Two types are encountered—one around fittings or connections; the other, part packings in cylinders, valves, etc. Leakage around fittings is primarily due to lack of sealing contact between the flared end of the tube and the cone seat of the tube fitting. Four reasons may be cited for this fault:

1. Scratched or marred surface of cone end of fitting.

2. Dirt or foreign matter between cone and flare in assembly.

3. Poor flaring or cracked tubing due to improper flaring (Figs. 6 and 7).

4. Tube failures due to faulty flaring of tube ends (see Fig. 8) or incorrect bends in tubing (see Figs. 9 and 10).

In Fig. 8, an end of $\frac{1}{4}$ in. tubing which pulled out of the fitting due to a flare in which one side was formed thinner than the other is seen at *A*. At *B*, a tube end which did not pull out, but which leaked continuously, is shown. And at *C* is seen a $\frac{1}{8}$ in. tube which pulled out of its fitting as in *A*. Next, *D* is $\frac{1}{2}$ in. tubing in which the flare broke away from the tube through excessive tightening of the tube nut, which caused an extremely thin and weak section at the flare. And *E* illustrates an end of $\frac{3}{4}$ in. tubing on which excessive wrench torque caused failure or breakage behind the flare. In this picture, the flare is still held between the nut and fitting.

These five conditions can only be corrected by proper instruction of the personnel who flare the tubes and install the tubing and fittings. It is impossible to put too much emphasis on the need of instruction along these lines. Leakage can rarely be detected by inspection, due to the impossibility of applying test pressures not greater than relief valve settings. Furthermore, such leakage starts as slow seepage and will not be noted unless the pressure is maintained for a period of 5 hr. or more. This, of course, is difficult to do under production schedules.

Leakage past packings may be due to incorrect packing installation, defective packings, marred or scored cylinders or piston rods, and incorrect diameters in packing grooves, pistons, heads, and cylinder bores.

Electric Controls

(*Continued from page* 145)

available to operate the parts.

The relay depicted in Fig. 2a has stiffening ribs at the lower left hand corner. If a device is too flexible, the vibration may cause relative movement of the parts and thereby cause improper operations. Stroboscopic observation of the operation of a device while on a vibration test stand will often disclose weaknesses which can be corrected by minor changes.

The values of acceleration encountered on planes are generally less than 10 G. It is wise, however, to design devices to operate satisfactorily under accelerations as large as 25 G. Design principles which make devices suitable for operation under conditions of vibration also can be applied to make devices suitable for the accelerations which may be encountered.

High Altitude

Devices for the planes of today should be designed to operate satisfactorily at all altitudes from sea level to 50,000 ft. This covers ranges of pressures from 2 to 14.7 psi.

The most serious effect of high altitude on electrical devices is the tendency for arcs to hang on at low pressures. This condition was not serious when the standard voltage of aircraft systems was 12 v. Silver contacts do not sustain arcs at voltages below 16 v., the ionization voltage of silver. But when the standard voltage of planes was increased to 24 v., the contact troubles increased many fold.

Fortunately, tests indicate that the use of two contacts in series in a double-break form of contact device overcomes many of the difficulties. The amount of contact opening for two contacts in series is much less than the contact opening necessary to obtain the same rating with a single break contact.

When testing for operation at high altitudes, it is not sufficient to make tests at the highest altitude for which the device will be rated. Some contact mechanisms under certain current conditions operate better at 30,000 ft. altitude than at 40,000 ft., while other mechanisms show an opposite tendency. General indications point to improved contact action at altitudes above 50,000 ft.

The reduced breakdown voltage of air at low pressures must also be taken into account when designing electric equipment for aircraft. High potential breakdown voltages at sea level are approximately three times as high as at 40,000 ft. altitude. So a device must be designed to withstand 4,500 v. at sea level in order to withstand 1,500 v. at high altitude.

Temperature, Humidity, and Salt Atmosphere

Temperature conditions encountered on aircraft are particularly severe. Today, specifications require that aircraft devices must operate satisfactorily at

temperatures as low as minus 70 deg. F. and as high as plus 200 deg. F. The designer of devices for aircraft is very limited in the choice of materials that are suitable for this temperature range. Many plastic parts become extremely brittle at low temperatures and lose their shape entirely at high temperatures. Extreme care must be used in choice of metals so that unequal expansions due to temperature changes do not result in faulty operation.

Striving for minimum weight, it is often desirable to use aluminum posts on relays, but the basic magnetic structure must still be iron. A combination of these two materials over the high temperature range may result in incorrect calibration at extreme values of temperature.

Another effect of temperature which must be carefully watched is the stiffening of diaphragms on pressure switches. Pressure switches which operate on differentials of a fraction of 1 psi. at normal temperatures may require 20 or 30 psi. to operate them at low temperatures. Furthermore, the life of the diaphragm at low temperatures will be greatly reduced.

Many other difficulties are encountered at low temperatures, such as change of timing of magnetic time-delay relays, due to the greatly increased conductivity of the copper shading coil. It is essential, since no general rule can be set up to cover all the difficulties which may be encountered, that devices should be thoroughly tested under the extremes of temperature conditions before release for production.

Humidity conditions encountered on planes are also extremely severe. A plane may be stationed in the jungles for weeks with the humidity as high as 95 percent and the temperature at 100 deg. F. All parts of devices are extremely subject to corrosion under these conditions. Steel parts must be plated to prevent rusting. Electric coils must be very carefully designed with completely non-corrosive materials to eliminate corrosion of the fine wires of the coils under these severe conditions.

A very modern approach to the solution of some humidity problems is the Dri-Film treatment, a new General Electric development. When insulating material is treated with Dri-Film, the high potential breakdown value under conditions of severe humidity is greatly increased. The leakage resistance across the surface is also much higher than that of untreated material. This treatment is particularly valuable on devices used in conjunction with electronic apparatus.

Salt atmosphere encountered by Navy planes and many Army planes must also be considered in designing devices for aircraft. Salt spray tests quickly show up weaknesses which can be eliminated by the proper choice of materials and of protective coatings.

Weight and Size

The weight of a device is triply important on a plane. A 5-lb. device is actually equivalent to 15 lb. because 10 lb. of plane is necessary to lift it. So the demands of the aircraft designer for lighter and still lighter devices can well be appreciated.

One of the smallest electrical devices designed for aircraft use is the switchette, a 10-amp. snap-action contact mechanism. One form of the switchette is shown in Fig. 3. This device weighs only ½ oz. and is but one-third the size and weight of similar devices which were not functionally designed for aircraft.

From a primary standpoint, the switchette when used on a plane saves space and weight because it is smaller and lighter than the devices it can replace. But there is a larger secondary saving realized, since the enclosures and mounting brackets can be proportionately reduced in size and weight.

Quality

Most important requisite of a well designed electric aircraft control is quality. Successful operation of the plane is dependent upon satisfactory operation of these controls. Quality must be designed and built into these controls. Tests must be severe and complete. Factory inspection must be rigid. Supervision must be alert. Finally, designs must fit their applications.

There is a slogan in the aircraft industry: "This is an airplane part. The pilot and the passengers depend upon you for their safety. Do your best."

A.C. vs D.C.

(*Continued from page* 141)

Provision for isolated operation, even though it may only be a temporary requirement, makes the system design more difficult. Facilities for transferring loads are required, and these must be so arranged that excessive overloading of one alternator is prevented. In certain cases this may not be entirely possible, since increased generating capacity is required for a reliable installation. In special cases where synchronous operation of several motors is necessary, such as wing flap motors, it is difficult to arrive at a simple system and yet supply power to these widely separated devices from a single power source. This would not be true under conditions of parallel operation. Because of these difficulties, and since coordination of protective devices are more difficult, a weight penalty must be accepted in providing for isolated operation of the alternators.

Before discussing the design of the distribution or bus system it is advisable to make a few comments on protection for faults in apparatus, since these will occur most frequently. Speed in clearing such faults reduces damage to the apparatus, reduces fire hazard, shortens the time of power failure to other loads, reduces the possibility of losing synchronism, and makes protection of the distribution system easier.

Alternator protection can be obtained most effectively by means of differential current. One current transformer and one instantaneous relay are required per phase. A short-circuit between phases or to ground will operate one or more of these relays, which trip the alternator breaker and opens the alternator field circuit.

Load devices are easier to protect than alternators because they do not feed sustained current into an extern' fault. Instantaneous overcurrent protection set above locked-rotor current, above inverse-time overcurrent protection, or both, can be used and will usually be lighter than differential protection. A fusible link, a bimetal relay, or a magnetic relay can be used, but in any case the total time required to interrupt a fault in the apparatus must be short enough to permit fast protection for the rest of the system.

If inverse time overcurrent is used in both load and system protection, the devices must coordinate throughout the expected range of ambient temperature and short-circuit current. This will be easier if the load and system protective devices are of the same type, that is, either fusible links of the same material or similar bimetals. In some of the systems now contemplated, load protective devices must complete their operation in less than .01 sec. at a current level of 3,000 amp. if they are not to slow down the system protection.

Combat experience indicates that most of the faults occurring in the cable-runs themselves are open circuits. For this reason, alone, it is desirable to provide two or more circuits over a high percentage of the current path to important loads. Use of multiple circuits also makes it possible to isolate short-circuited sections without loss of any load. The distance between circuits should be great enough to prevent simultaneous damage by the same projectile.

Current carrying ability of a multiple-circuit feeder will be greater than that of a single circuit of the same total cross section because of the in-

"When wing to wing across the sky the death-defying Forts go by..."

The following tribute to American production of 100-octane gasoline was received by Petroleum Administrator Ickes from the Right Honorable Geoffrey Lloyd, chairman of the British Oil Control Board.

Believe me, Sam, I'm not too proud
To cheer, like any baseball crowd
When wing to wing across the sky
The death-defying Forts go by.
And gazing, I can guess the force
That hurls on their unerring course
Those roaring giants through the air
Has not just come from anywhere,
And, when I'm told, I too can see
Behind that buoyant armoury
The maze of derricks, rigs and drills;
The mushroom growth of monstrous stills;
The pipelines racing point-to-point
With welders sealing every joint;
The fiery furnace heat that powers
The sky-high fractionating towers;
The stewards in the cocktail bar
Who mix the potent brew of war
And build a highball, Houdry-based,*
To suit the most high-flying taste;
With anxious care they calculate
The right amount of alkylate,
And iso-pentane (not too much)
Cumene perhaps, but just a touch,
And then to give the Fockes hell,
A seasoning of T.E.L. *(Tetraethyl Lead)*
All tinted to an emerald shade
To show that they have made the Grade.
Just what it costs I think I know
To make the priceless green juice flow
(I squeeze out every drop I can
from my old joint in Abadan).
So when I see the precious stuff
Gush out in floods (though not enough;)
I take my hat off (not a high one—
The Board of Trade won't let me buy one).

LONDON, NOVEMBER 17, 1943

* *During two years of war, almost* all *the catalytically cracked aviation gasoline for the United Nations has been produced by Houdry Processes.*

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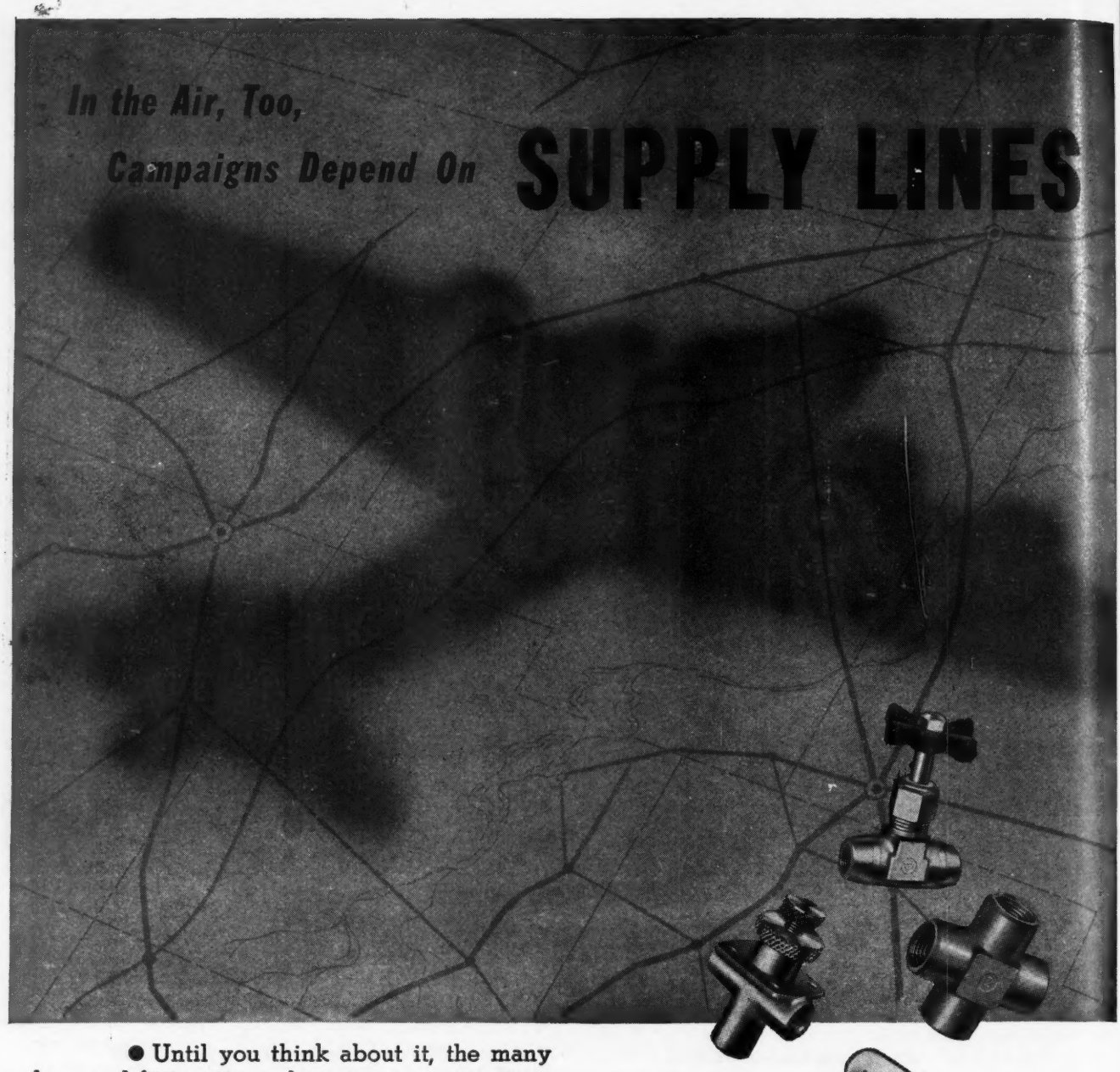
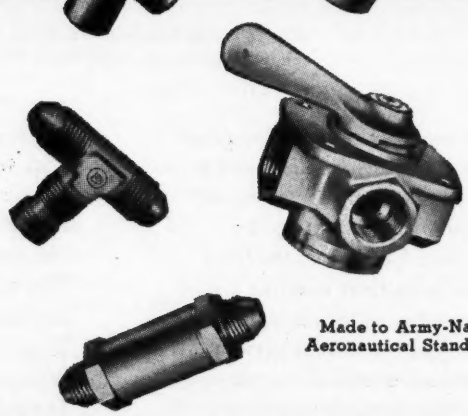


● Until you think about it, the many valves and fittings in a plane may seem no more important than nuts, bolts and rivets.

But Dole Aircraft Valves and Fittings have proved that precise uniformity within specified tolerances is a quality which prevents failures in the many supply lines—gas, oil, air, oxygen, etc.—where failure would endanger large plans.

When you need valves and fittings remember the high standards of Dole design and manufacture.



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creased radiating surface. The several circuits must be separated sufficiently to avoid mutual heating in order to take full advantage of this factor. For example, one No. 8 wire is rated 73 amp. while four No. 14 wires will carry 124 amp. if widely separated. On the basis of current-carrying ability alone, considerable weight can be saved by using multiple circuits even when mounting clips and terminal equipment are considered.

If less copper cross section is used so as to effect a saving in weight, the resistance of the circuit will be increased. This will increase the resistive component of the voltage regulation. The reactive component will be reduced because of the decrease in reactance. For a twisted group (see Fig. 3) the regulation at 80 percent power factor of a three-phase circuit having one No. 8 conductor per phase would be $\sqrt{3}(.627 \times .8 + .21 \times .6) = 1.08$ v. (LL)/1,000 amp.-ft. Two No. 12 wires in parallel per phase will have slightly higher current carrying capacity but will have a regulation of $\sqrt{3}/2(1.735 \times .8 + .24 \times .6) = 1.31$ v. (LL)/1,000 amp.-ft.

The No. 8 wire weighs 190 lb. per 1,000 ft. of three-phase circuit, and the two No. 12's weigh 146 lb. Thus the weight-saving possibilities of multiple circuits can only be fully realized if the system voltage is sufficiently so high that wire sizes are determined by current carrying capacity rather than by voltage regulation.

Keeping Unbalance Down

In using multiple circuits one must make sure that the impedances of the several branches are nearly equal so that the current will divide equally among them. This will not be difficult in long runs or with small conductors where variation in the resistance of terminal equipment and of contacts is negligibly small. Unbalance caused by the difference in the length of cable run should be kept to a few percent if possible, since it must otherwise be considered in the short-circuit coordination of the system.

When a short-circuit occurs in one section of a multiple circuit some means must be found to disconnect that section from the remainder of the system. Just as in faulted apparatus it would be desirable to use differential current as a means of detecting the faulted section and disconnect it by means of circuit breakers, but such a scheme would be ridiculously heavy. Current balance relays have been suggested but are also too heavy. The only practical scheme which has been suggested for aircraft is the use of fusible sectionalizing links.

Fig. 4 shows an example of this arrangement during an 800 amp. ground fault. Referring to the current time curves of Fig. 5, the link at Fig. 4 (a) would interrupt in .035 sec. without damage to the other links. Then the current in the link Fig. 4 (b) would become 800 amp. and clear in less than .02 sec. The actual time can be calculated by setting the total I^2t = 15,000 amp.^{2} sec.

If a second fault were to occur in one of the other sections a similar action would take place. A third fault would cause the same current to flow in the remaining good circuit as in the faulted circuit, and the wrong link might melt or at least be damaged. Note that in this example, selectivity has been obtained by virtue of current differences in links of the same rating. In more complicated circuits, links of different ratings can also be used to advantage.

Fig. 4 has been used only as an example of the general method of approaching the problem of fault protection. The big advantage of a fusible link over other protectors is that it combines the function of relay and circuit breaker in one small lightweight device with no moving parts. A complete three-phase device for a 20-amp. circuit with a plug-in base and terminals weighs less than 4 oz. and occupies less than 5 cu.in. The effect of ambient temperature on time of operation can be made very small by using a metal which has a high melting point, such as copper or silver.

The principal disadvantage of this scheme of protection is that the links must be replaced whenever a fault has occurred. A visual operation indicator is provided for each phase of each link. Since the faulted circuit has to be repaired anyway, the indicators act as an aid in finding the faulted cable. By properly designing the base it can be made difficult to substitute a jumper for a blown link or to use the wrong rating.

An important consideration in applying fusible links for short-circuit protection is to make sure they will not blow on peak load currents or on starting inrush. They should not be allowed to function as overload devices. It is certainly better to bring back a plane with scorched insulation than to lose power to gun turrets during a battle. In this respect, the links are applied like the limiters in industrial power networks—not fuses in house wiring. Two guides can be used in this respect. First, the maximum load current through any limiter should not exceed the minimum damage curve (see Fig. 5). Second, the minimum melting current of the limiter should be about three times the normal current rating of the wire with which it is used. Under these conditions the limiters will not blow on any current that the wire can carry without excessive damage.

The percentage of the total system exposure represented by the load and generator buses is very small. For this reason faults in these locations represent a second order possibility. However, in most system layouts a lucky hit on a bus would cause the loss of a large block of load. In the example of Fig. 4, a fault at either end of the circuit would cause the loss of the entire load.

Fig. 6 shows a complete system in which electrical protection has been provided to minimize the amount of load lost as a result of bus faults. In this system each feeder will clear *one* bus fault without loss of load on other buses, *or one* cable fault without loss of any load. However, these circuits require very close coordination which may result in some damage to limiters adjacent to the fault, especially when provision must be made for a wide range of fault current. Also, second faults may cause loss of load on the entire feeder if they occur at an unfavorable location.

A fault on a bus at the generator terminals can be cleared by including this bus within the generator differential protection zone and by tripping the generator breaker.

Further Fault Procedure

Faults on the central bus or in any of the circuit breakers can not be cleared electrically without a rather complicated relaying system. There are two ways in which it would be possible to disconnect the generators under these conditions without damage to the rest of the system, after which it would be possible for the flight engineer to isolate manually the faulty section:

1. The alternator control system includes a relay which will trip the generator breaker if the excitation stays at a high level for several seconds. Under favorable conditions it is possible to coordinate the operating time of this relay with the damaging time of the limiters in the generator loads.

2. Where this coordination is not feasible, ground fault protection can be obtained by mounting the bus and circuit breakers on an insulated metal panel and connecting a current relay between this bus and ground. This relay can then be arranged to trip all generator circuit breakers. This "fault bus" protection scheme can be made automatic by using separate insulated panels and relays for each bus section and each tie breaker, although the resulting scheme is fairly complicated.

Concerning the complication and limitations imposed by electrical bus

protection, it is questionable whether the complication is justified since there is small probability of bus faults. Another approach to this problem is to use as few buses as possible and locate them where mechanical armor can be provided without serious weight penalty.

Fig. 7 is an example of such a system. The generator buses, the central bus, and the load buses in the nose and tail depend on armor. Faults on the buses at the ends of the wing feeders clear by melting the limiters in all three circuits, but other loads are not dropped. Faults on the buses which are connected to each feeder through small limiters cause the loss of all load on the faulted bus, but other circuits are not affected.

If it is not possible to armor all of these locations effectively without excessive weight penalty, the system shown in Fig. 8 may prove to be advantageous. The total conductor weight for this system will usually be greater than for the arrangements in Figs. 6 and 7, but the weight of the central bus and its protection are eliminated. This system has been shown without provision for isolated operation and with electrical protection for load buses.

The load bus protective scheme shown limits the number of faults which can be cleared in the main circuits, and those buses which supply only one or two small loads should probably be changed to the layout shown in Fig. 7. This general scheme can also be arranged for isolated operation by adding sectionalizing circuit breakers at the nose and tail and between each pair of generators in the wings. It may also be desirable to increase the number of circuits in the main loop if the load density is sufficiently high.

From the evidence available, it appears necessary that a.c. distribution systems for large aircraft provide fast automatic fault protection for a limited number of open-and-short-circuits. Multiple circuits with fusible sectionalizing links offer the most effective means of obtaining this protection without execssive weight and complication. Some of the critical parts of the system can be protected more effectively by mechanical armor.

Here's the "T" Loan

(*Continued from page* 115)

But in the middle of 1943, cancellations began cropping up. By then this same contractor had $10,000,000 in his own working capital and $10,000,000 in V loans. Upon termination the government would take care of his V loan all right, but the $10,000,000 in working capital would most likely be nearly all tied up in cancellation claims and hence not available for reconversion or the payrolls. So the VT-loan procedure was launched last September to make loans on the maximum investment in war production contracts, as differentiated from V loans, which covered credit needs alone.

Experience has shown that it takes too long to get the V-type loans arranged, as two examples show: According to Walter A. Mogensen, treasurer of The Aviation Corp., his company spent 8 mo. negotiating one of these loans, while Webb Wilson, treasurer of Fairchild Engine & Airplane Corp., tried for 3 mo. to get a loan to finance production, then gave up due to a disagreement between one of the services and the banks.

More than one prime contractor in the industry has had trouble negotiating these loans, indeed, the feeling is widespread in the industry that the red tape is so tough to unwind that a war contractor with cancellations on his hands might just as well wait for final payment on his claims.

Both V and VT loans were set up under the President's war powers for war production. The Attorney General has issued a sympathetic opinion that VT loans can be taken out after contracts have been terminated. But both contractors and settlement officials realize this opinion has no standing in court. Furthermore, VT loans are ineffective from the termination standpoints of both maturity and interest.

Thus Congress will be asked to legalize the new T loan, which has been under consideration for the past few weeks by the Baruch group, War Department, Federal Reserve, and other agencies. The T loan will deal with termination only and will be available after cancellation. It will carry loans up to 90 percent and be an extended debt that carries no maturity.

Perhaps the best news for the aircraft industry in this termination-financing program is that interest costs on termination loans will be charged off as legitimate termination expenses. In other words, the government plans to pay the interest.

The War Department, as well as the Baruch group, believes that aircraft contractors in particular must be protected against a "squeeze on interest." Private financing agencies, of course, can give no protection on interest. Thus it is anticipated that interest in the settlement period on borrowed and invested money will be an allowable charge in termination settlements up to an interest rate of around 2.5 percent.

Theory back of this proposal is that termination loans are required by the contractor because immediate cancellation settlement will not be forthcoming and, accordingly, interest on such loans is a cost the contractor should not be called upon to bear.

Termination regulations that do not recognize interest payments as a specific cost place at a disadvantage the contractor who resorts to private bank loans, while contractors who get government guaranteed loans are relieved of interest payments under provisions governing such loans. But if the contractor has the cost of his loans cared for by the government in all cases, private and government loans will be on a par with each other.

Baruch would like to get all contractors "under cover"; he feels that very few war contractors can prudently be without VT loans. Later on, these loans can be transferred to the new T loans. But it may take Congress some time to pass the necessary legislation to set up the T loans, and war contractors should be covered as far as is now possible against cancellations that may come any day.

After all, contractors have had 20 mo. in which to secure V loans, unsatisfactory as they may be. There are more than 5,000 V and VT loans outstanding, with approved loans totalling around $6,500,000,000. About $500,000,000 of this total are aircraft loans, which would seem a fairly small amount for an industry doing better than a $12,000,000,000 annual volume.

Bankers who advise against government guaranteed loans give mighty poor advice, in the opinion of Washington officials. One contractor, for instance, who pleaded with government officials for a VT loan the day he received his cancellation notification, was crisply told that "this is not our day

A TIP FOR TERMINATED CONTRACTORS

To keep their credit channels open with the banks, aircraft manufacturers should be prepared to make estimates (1) of their monthly cash income, (2) of their monthly cash outgo, and (3) of their future (after termination) earnings. Bankers will want these new figures—for criteria of the last three years won't mean much when termination day rolls around.

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Just as a bomber goes into the final bombing run, "Elmer", the automatic pilot, takes over the big ship and guides it straight and steady right on the target.

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Today, the full capacity of Holtzer-Cabot facilities are being used in building fractional HP motors for military use. However, our motor development engineers are available for solving special fractional HP motor problems for contemplated peace-time products.

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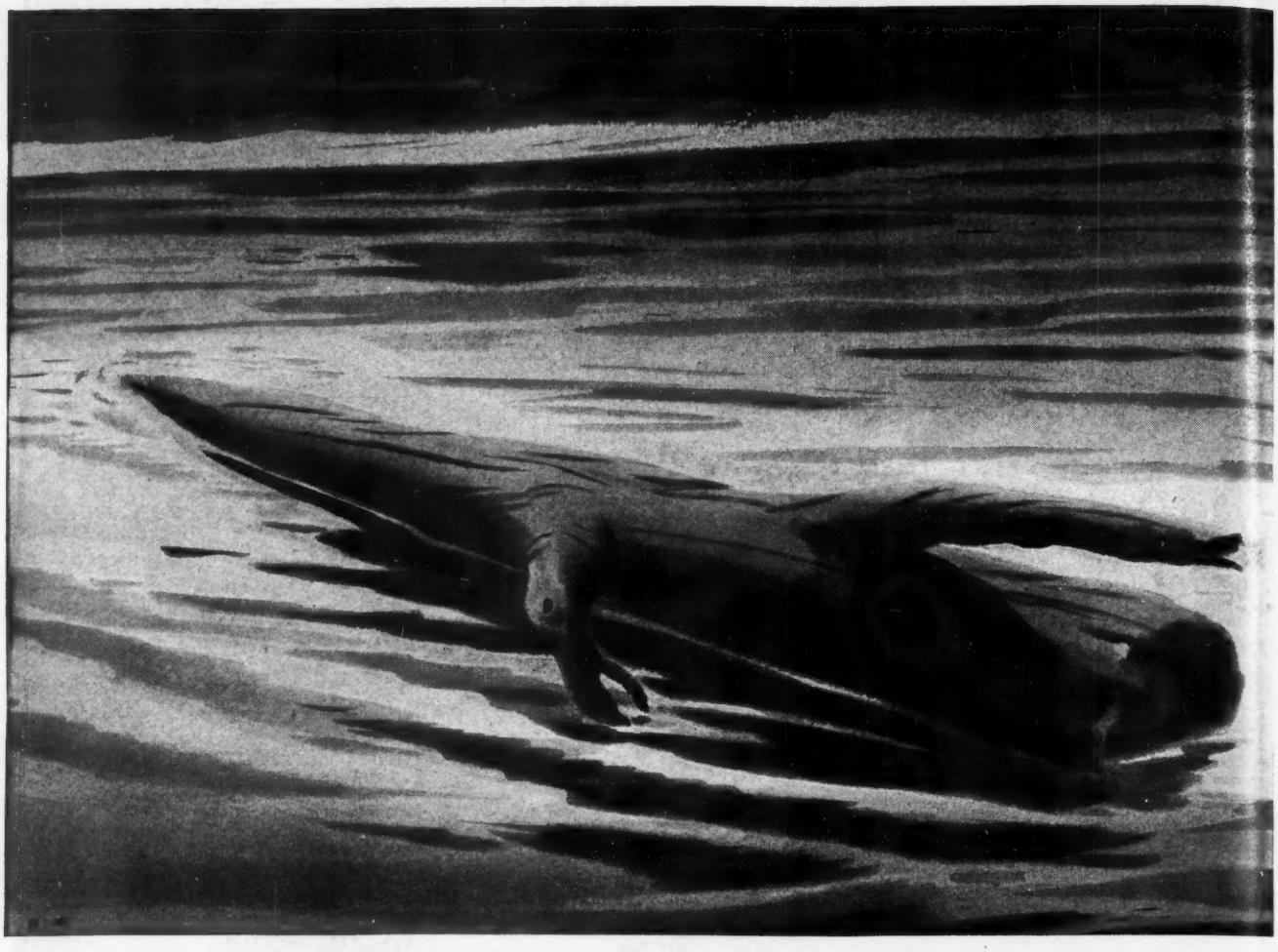


Not All "Water Logging" Happens In Water

A LOG can absorb enough water to lose buoyancy and sink. Even though none of the materials you use look like logs, many of them may absorb weight just as readily, and much more rapidly.

Take for example, oil seals, hose, packing, gaskets, grommets, diaphragms, and all other resilient parts. When used in the presence of oil, these may act just like a log by absorbing weight not included in original design calculations.

Dead weight caused by the oil-absorption of thousands of such resilient parts in a single plane may "sink" the performance of the ship.

But Hycar synthetic rubber with its light weight, and its superb resistance to oil to keep it light, gives protection against increased dead weight not offered by any other comparable material. Hycar is 15% to 25% lighter than many other synthetics, and retains this important quality throughout its long life.

Oil-swell can be closely controlled with Hycar to insure dimensional stability. And Hycar has an operating range of −65° to +250° F. and abrasion resistance 50% better than natural rubber. Unlike many other oil-resistant synthetic rubbers, Hycar has a minimum tendency to cold flow after taking the initial deformation, even at elevated temperatures.

These are qualities you need in resilient materials used in the presence of oil. Let our technical service staff help solve your individual problems. *Hycar Chemical Company, Akron 8, Ohio.*

Hycar

LARGEST PRIVATE PRODUCER OF BUTADIENE TYPE

Synthetic Rubber

to leap after cancelled contracts."

Incidentally, if there is a great mass of applications for T loans after termination, such as may be expected when the European phase of the war ends, government officials fear that the whole loan administrative machinery may bog down. That is the main reason they want contractors to get in their loan requests prior to termination and then convert them later to T loans.

A War Department recommendation which also requires legislative action would set up mandatory provisions for immediate partial payments on terminated contracts.

As matters stand now partial payments are permitted on termination, but in actual practice they are rarely made by the government disbursing officer since he is held personally liable for any excess paid. That, of course, is an intolerable situation. No government official is going to take such a chance of putting himself out on a limb. As a War Department official recently remarked, "there isn't that much courage in the Army."

Payments of 100 percent would be mandatory on undisputed claims—that is, those that are subject to no dispute in either direction. Army experience to date has been that 60 to 75 percent of contract cost items fall in this "no dispute" classification and therefore could be allowed the 100 percent partial payment.

Mandatory partial payments also would be made to prime contractors and first-level subcontractors. This partial payment program would be of chief value to the prime contractor. But first there must be legislation to remove the personal liability of the disbursing officer, except in cases of fraud, and also the personal liability of the prime contractor in his relations with subcontractors.

It is further hoped to decentralize procedure on the proposed T loans so that the Federal Reserve banks can be delegated authority to make loans up to $250,000. As it stands now, each federal reserve bank district can issue loans up to only $100,000 upon approval of the regional contracting officer without reference to Washington.

Then there is the matter of simplification. The V and VT loans have been a lawyer's field day. When federal reserve officials first proposed the V-loan formula it consisted of one page. After the lawyers got hold of it, so the story goes, it developed into 129 closely written pages.

The entire loan system should be simplified, top government men feel, by the use of a small note of the ordinary promissory type, qualified by a brief statement of the guaranty and of a few of the negotiated settlement problems involved. This would remove some of the complicated factors that so bedevil the small contractors and local banks today.

The government also plans to do something for those on the subcontract level. For one thing, another type of T loan is being considered, one whereby local banks can loan on the basis of a single contract.

The 17 committees of Congress dealing in one way or another with termination planning can also be expected to work up some legislation of their own favorable to the hard-pressed little contractor. One solution for the plight in which the subcontractor finds himself upon termination may be to bring the Smaller War Plants Corp. into the picture more aggressively. The SWPC was formed in desperation by the WPB some time ago to ward off pressure from small business groups for war contracts. It has had a succession of executive heads who couldn't make much progress on their difficult assignment. Indeed, no one in Washington thought they could.

Even if the SWPC wasn't a howling success in helping the small concern get war work, it would seem that the organization now has an opportunity to aid the small firm with subcontracts to finance reconversion. That is, if Congress and the other government agencies will give SWPC the green light to step in and help the little fellow.

When bankers think there's too great a risk in advancing loans on claims derived from terminated subcontracts, the SWPC might guarantee the loans to make sure the small factories' working cash would not be exhausted. It would take Congressional action to enable the SWPC to do this bit of financing.

The comptroller general reputedly takes the position that SWPC small business termination loans should be preceded by a preliminary determination of claims. With 1,000,000 subcontracts outstanding, the SWPC feels that it would be practically impossible to check on the tremendous number of these subcontract claims within a reasonable time.

Thus the whole idea of a "quick payoff" could be thwarted. But previous attempts to bring in accounting office red tape have been beaten down and probably will be again.

Nearly all termination thinking in Washington today resolves itself around the point that the contractor must get his money—and promptly. The next step is Congressional action to legalize the above-outlined procedures and such other necessary procedures which come up in the subsequent course of events.

More Planes Quicker

(*Continued from page* 113)

try by war needs, it was only natural that some duplication of effort would crop up. When time could be found to analyze its system one company found, for instance, that four departments were involved in establishing numbers on design changes pending their incorporation into the routine of the production line. As a result of the analysis, a change control department was set up, thereby eliminating three engineering forms representing a direct cost of 1,200 man-hours and 25,000 reproductions costing $1,750 a month. These direct savings are exclusive of mailing and filing costs, plus 3,000 man-hours of typewriter time every month.

No detail that will help save time and get out more airplanes is overlooked. For example, women tracing lettering on blueprints are provided with mechanical lettering guides. This not only saves their time but guarantees legibility which also saves engineers' more valuable time.

One of the latest wrinkles to make certain that any given part will work on any airplane of the same model is a "template airplane," a mock-up made of the most economical and easily worked materials, but dimensionally identical to the actual flying airplane. Thus, fitting of a part of this "template" is positive proof that the tools, jigs, fixtures, and the part itself are ready for production. This company reports that all future production changes, such as those required by military needs, will be proven in this manner before being put into the production line.

Despite the industry's unparalleled expansion and the lowered experience-level among engineering personnel, the airplanes being designed for production today are far superior to their predecessors. This has been accomplished by constantly greater efficiency in utilization of the few experienced personnel through better planning and organization, resulting in such savings as those already noted.

But engineering is only one phase of the many-faceted manpower problem. Perhaps less tangible in many cases, but nonetheless important, are the problems of industrial relations, which cover every operation of the human side of industry, especially in personnel administration and labor relations. These manpower phases begin right with procurement of the employee and thereafter continue, not only through his activities on the job but often into his activities after the day's work is done.

Recruiting of workers, whether they

be men or women, boys or girls, able-bodied or handicapped, has been carried on through all accepted mediums and frequently with new approaches. All the techniques of the skilled interviewer, as well as the tests of mechanical and mental aptitude, are used to determine the potential value and best place for the recruit. Not only is it essential that the selection of the employee be done carefully but it is also vital that he or she be placed in the most suitable job.

Before new recruits go to work they are usually given orientation courses showing the over-all picture of the company's operation, how the recruit's future job fits into that picture, and how important it is that the job be done right so that the whole complicated task of building airplanes can be done efficiently and successfully.

Since all workers' skills are known and cataloged from the time they start work, then kept up to date on an "electrofile" card system, job openings are quickly and efficiently filled from within the plants. The cards used are coded so that they can be sorted by a simple operation to locate any desired experience on a moment's notice. Recruiting of new workers, however, is a continuing process, particularly for some companies which have been seriously restricted because of the War Manpower Commission's Controlled Referral Plan.

In at least one locality this plan refers men workers only to heavier industries, which has meant that the aircraft producers in that area have had to hire even more women than ever. Although women are equal or superior to men for many jobs, they consistently show a higher rate of terminations, or quits, meaning that much more time must be devoted to training replacements. In this connection, the survey revealed that at the end of 1943, East Coast Council member companies had 40 percent women among "direct" employees, compared with less than ½ percent two years before. In total employment, of course, the ratio of women workers runs much higher.

Varied Training

The very task of training aircraft workers by the thousands brought forth a variety of practices which, while similar, were varied to meet local conditions. One plant, as an example, used a vocational school to train more than 2,000 key workers; later it opened its own shop school. Other companies furnished instructors and materials, using local existing school facilities. One such program has already given more than 1,250,000 man-hours of training.

Recently it has proved difficult to send employees out of the plants to vocational schools, resulting in more in-plant, or vestibule training. This has, however, proved advantageous, especially for training women and younger workers, for they work with the same tools and materials and at the same pace called for when they make the transition to the production line itself.

In the training field, no stone has been left unturned to help employees do a better job. Wide use, for instance, is made of movies, the pictures ranging from animated cartoons to complete "performances" showing the whole sequence of a given job. Graphic illustrations of the part involved, are used extensively to replace blueprints which, to many, are simply incomprehensible. These illustrations are often elaborate perspective or phantom drawings, use of which has given employment to many artists from the advertising and commercial art fields.

With the manpower barrel already scraped pretty clean—and production schedules constantly going up—aircraft manufacturers are still faced with the problem of providing adequate supervision. But, with capable personnel outside the plants practically non-existent, supervisors have been developed from within the organizations themselves. They have been developed by training programs giving potential leaders everything from an opportunity to increase their mechanical knowledge down to such important details as the proper way to give an order to a subordinate.

Perhaps one of the outstanding reasons the aircraft manufacturers have the best big-industry absentee record is the fact that manpower utilization has been increased by concerted "off-the-job" activities—activities that help keep the employee on the job.

Some companies, for example, maintain employees' personal service departments, manned by trained social workers who interview workers and their families, visit homes, also hospitals and other institutions, arrange hospitalization, contact creditors, help prepare budgets, and generally put themselves at the call of employees for personal, domestic, financial, and health problems.

In another case counselors are assigned to every department on all shifts to help solve employee problems through advice and assistance. Employees have long since learned that their problems are treated in complete confidence, with the result that the counselors have been able to make material contributions toward reducing the absentee and quit rates.

Increasing manpower utilization by keeping the worker on the job is one of the primary aims of every company in the Council, the main reason safety programs occupy such important positions in their plans. One company gave special training to women on proper methods of lifting and carrying material to avoid injury. Value of this training is evidenced by the fact that not one of the 2,700 women who received the training has suffered even a back strain. In another case several hundred employees were trained as "safety monitors" for their departments. Thus regular productive employees serve as safety guards, training their fellow workers to make full use of the safety equipment provided.

These are but a few of the activities designed to help keep employees on the job. Others include child care centers, organizations to facilitate transportation to and from work, ration boards set up within the plants, liaison groups to work with draft boards, and committees detailed to help solve housing problems. In other instances, service stores provide at cost the necessary tools, safety shoes, gloves, and other items essential to the job.

The Flood of Ideas

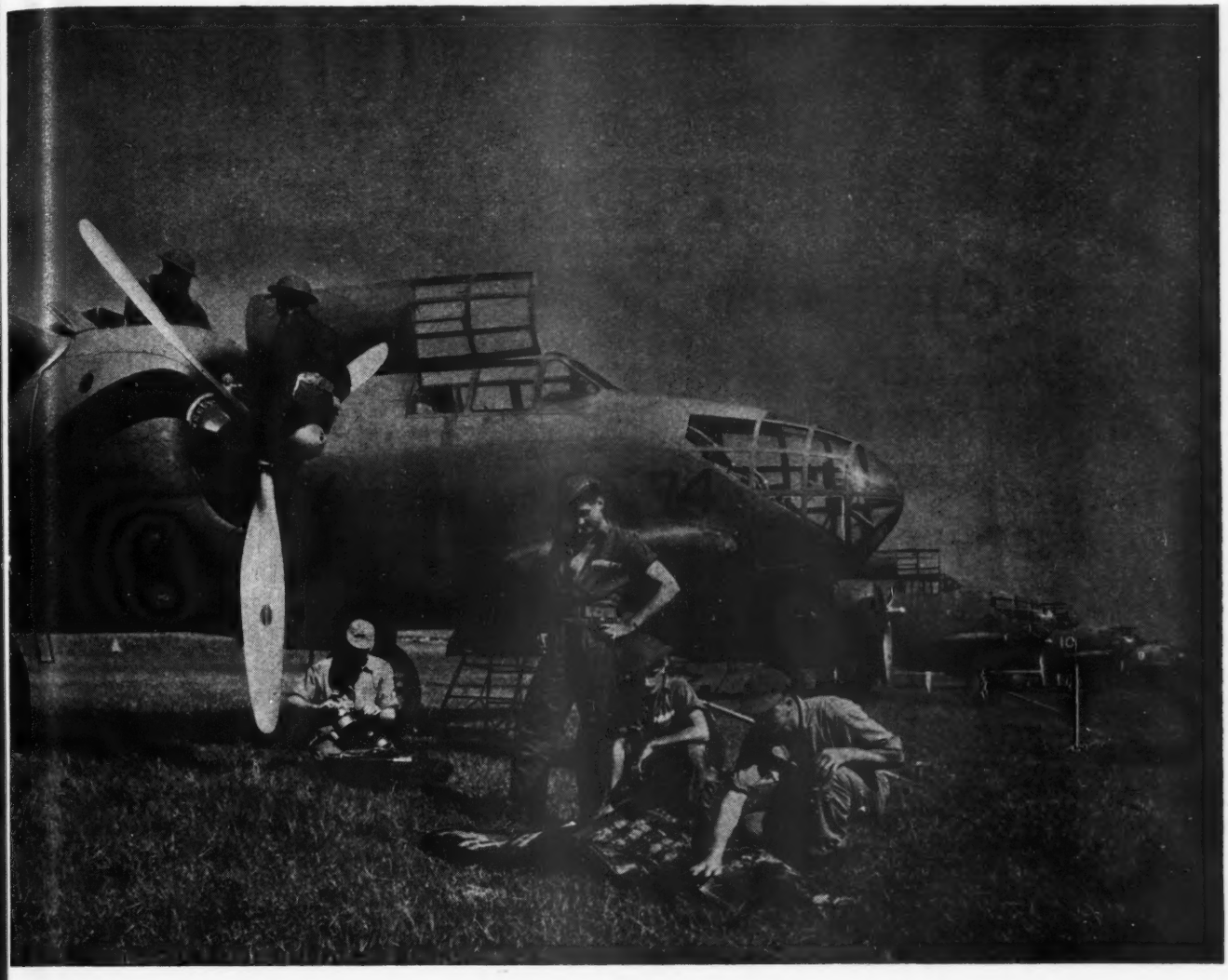
It is a tribute to those oft-libeled "average" Americans—the men and women who build our warplanes—that thousands upon thousands of ideas, gadgets, and tools designed to increase output per worker have come from the workers themselves. Every company has a "suggestion system" and rewards of cash or war bonds have been paid thousands of employees whose jobs range all the way from the simplest riveting operation up to factory superintendent.

Some of the greatest manpower saving schemes, though, have come from production departments. Remembering that an average fighter plane is an assembly of some 25,000 unit parts, held together by as many as 100,000 rivets, it is easy to visualize the complexity of the job. The work of production department engineers cannot be praised too highly; the country owes them a great debt.

While many of the ideas have involved "major operations," such as a complete change in plant layout, many have been extremely simple. One, for example, saved a company 120,000 man-hours a year by *cutting down* the supervisory staff by 25 percent and re-assigning duties.

What might be classed as one of the major operations involved a change in wing manufacturing technique. Under the old system, which took 650 man-hours per plane, the wings were moved from fixture to fixture. The present set-up uses new type fixtures mounted

FLEXIBLE in Range . . . RIGID in Quality



★ WILCO THERMOMETALS (thermostatic bimetals) have the *flexibility* to meet any temperature control or electrical resistance requirement—and the *quality* to maintain a tradition of excellence, which has continued unbroken for more than a quarter of a century.

★ Now functioning separately, now operating in conjunction with WILCO Electrical Contacts, WILCO THERMOMETALS are helping America win the war of the air, the sea and the land—helping through their matchless performance in Oil Temperature control, compensation in voltage regulators, and dependable action in many precision instruments.

★ Moreover, WILCO Aeralloy Electrical Contact Points are setting high standards of service in aircraft magnetos. Other WILCO Electrical Contacts are in tank, gun and ship applications—other WILCO THERMOMETALS in various instruments for the Army and Navy.

★ A SINGLE SOURCE OF SUPPLY—WILCO facilities permit manufacturing customers to secure both electrical contacts and thermostatic bimetal from a single source. This is important, for materials from these two groups are frequently used in conjunction, as parts in the same device. The most effective use of one necessitates a knowledge of the other.

★ WILCO sales and engineering representatives are familiar with both Electrical Contact and THERMOMETAL application. Send us your problems for analysis.

WILCO PRODUCTS ARE:

Contacts — Silver, Platinum, Tungsten, Alloys, Powder Metal. ***Thermostatic Metal***—High and Low Temperature with Electrical Resistance from 24 to 530 ohms per sq. mil,-ft. ***Precious Metal Collector Rings*** for rotating controls. ***Jacketed Wire***—Silver on Steel, Copper, Invar, or other combinations requested.

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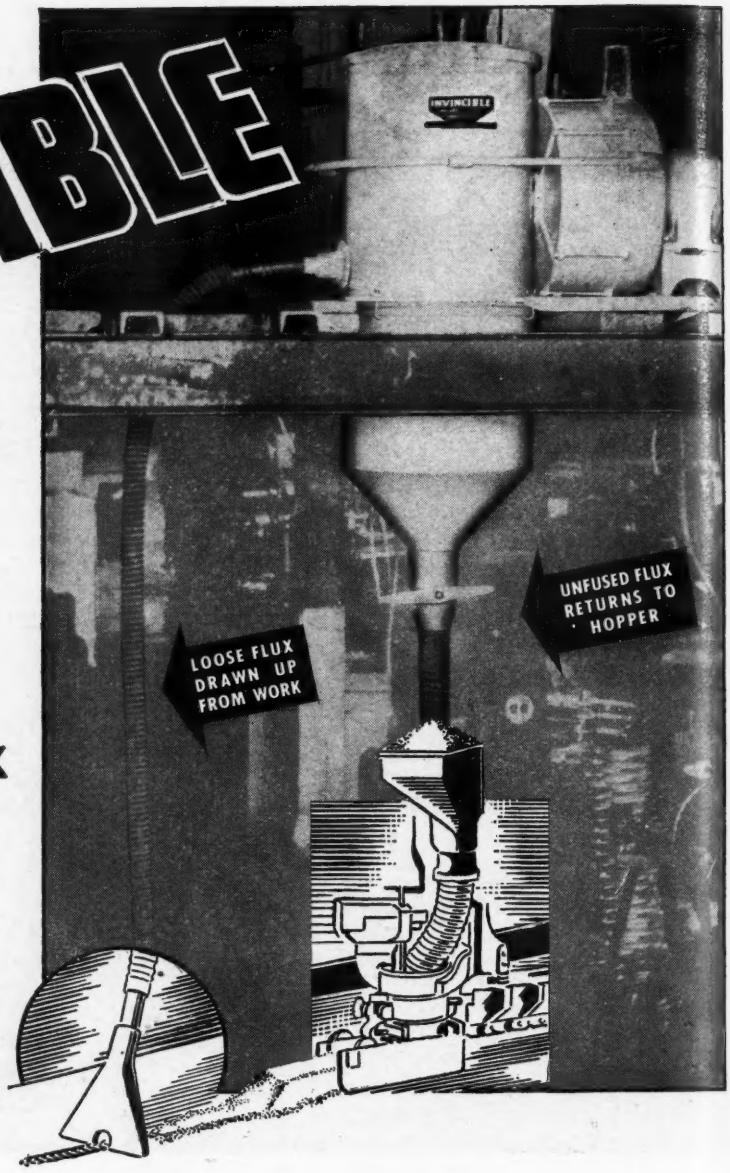
VACUUM EQUIPMENT Saves MANHOURS MATERIALS MONEY.....

RECOVERING UNFUSED WELDING FLUX



• The Invincible automatic flux recovery unit, the companion of the automatic welding head, is speeding up production and reducing welding costs.

Invincible flux recovery units automatically retrieve abrasive welding flux from work in progress, then separate the fused and unfused flux and return the latter to the hopper of the welding head.

On the average job, the value of the flux salvaged in a few weeks' time is greater than the cost of the Invincible equipment. In addition, there are substantial savings in manhours, and the elimination of costly disposal problems.

OTHER INVINCIBLE ADVANTAGES

1—Complete and positive separation precedes the vacuum producer; there is no wear on moving parts.

2—Abrasive action is offset by the use of rubber baffling and special designed inlet.

3—Invincible portable equipment is also available for welding applications requiring a manually operated recovery unit.

4—Invincible engineers have developed a unique "slag separator" which can be furnished as additional equipment. This "slag separator" also provides a convenient method of adding fresh flux to the reserve container.

May our engineers assist you with your recovery problems? Describe your welding operations so that we can tell you how Invincible equipment will save you time, money, and material.

INVINCIBLE VACUUM CLEANER MFG. CO.
DOVER, OHIO

FOR 35 YEARS, LEADERS IN INDUSTRIAL VACUUM EQUIPMENT

on a continuously moving conveyor which, coupled with new methods, has cut required man-hours by 35 percent.

This same company achieved a 400-percent production boost in its paint department by developing an automatic conveyor that turns out 5,200 pieces every 45 min. This new pace, in turn, required new speeds throughout the department and brought forth a simple but highly efficient device called a "pre-loader" on which all parts are arranged in advance by two workers—instead of eight to ten—and hooked into the conveyor systems which stops for only 15 sec.

Remarkable "Up and Down"

Another Council member company had three parallel final assembly lines, each with seven stations, or work positions. A new plant layout combined the three into one line of horseshoe shape with 28 stations. The greater number of stations permitted better breakdown analysis and operations specifications. Result: A 32 percent production increase *plus* a 42 percent manpower reduction.

But efforts to increase manpower utilization don't stop at the end of the production line, for an airplane doesn't count till it's been delivered to the Army or Navy. So better utilization efforts carry right on through the service, modification, and flight test departments, groups whose employees must be blessed with special versatility.

Such efforts are illustrated, at the airport, by what one company calls its central control board, which gives the exact location and complete information on the work status of every plane in the flight department. This information is kept up to the minute by schedule liaison coordinators located at strategic points throughout the department. The control board itself is actually a scale model of the airport and, since each plane is represented by a colored tag, an uneven flow of tags gives instantaneous warning that corrective action must be taken.

Another company has set up a special system for quick transport of versatile workers who can keep bottlenecks from developing. Four times daily, at the same time that availability of planes is being charted, this transportation group makes a survey among production foremen. Comparing the two shows immediately where manpower is needed so that workers can be dispatched within 15 min. after the start of each shift and right after the noon hour of the first shift.

Manpower utilization efforts go even beyond the companies' airports, often reaching clear out to subcontractors who can make or break production schedules. Most aircraft manufacturers therefore offer subcontractors regular services ranging all the way from orientation courses for key workers, through provision of tool design or the tools themselves, and up to actual supplying of fabricated parts.

Results of all the varied types of efforts taken by the aircraft industry can be summarized no better than by citing the findings of one company's survey of productivity of direct employees—those actively engaged in production, and exclusive of supervisory workers:

In 1941, an average of 4,420 direct labor employees produced 4,236,500 lb. of airframes, an average of 958.5 lb. per employee. In 1942, an average of 6,935 such workers turned out 8,726,000 lb., which meant the average per worker went up to 1,258.2 lb. In the first nine months of last year 11,869 direct workers built 16,381,900 lb., boosting their average to 1,380 lb. for the first three quarters of the year.

Thus, each direct employee averaged 79.9 lb. per month in 1941, boosting it in 1942 to 104.8 lb., and last year hit 153.2 lb. per month per worker. And that means each worker had nearly doubled his production.

To detail all the measures taken to achieve what can only be called production miracles would take volumes; just to *list* them would fill a tremendous book. Those cited here are merely typical of the tens of thousands of ideas, large and small, back of this one all-important fact: American aircraft workers are producing more than those of all the rest of the world combined.

Scott's Plan

(*Continued from page* 111)

pay of each individual company cover its own actual conversion time? We do not believe so, for an affirmative answer would indicate that the company intended re-hiring all released employees. It is hardly conceivable that any firms now in aircraft manufacturing can do that. Termination pay should be used as a temporary amelioration, not as an unemployment dole. In any event, the amount of money and the payment time-range we have established in our termination program are, we believe, adequate, fair to the employee, and possible of accomplishment.

Termination pay, though, is but half the problem; it covers the employee but not the employer. We point out here that America's war production program has brought the growth of many companies whose resourcefulness, ingenuity, and genuine business ability entitled them to the belief that they are qualified for a place in the nation's postwar industrial life. This is especially true of many aviation organizations with a short, but nonetheless vital, prewar history—companies whose ingenuity can be a powerful factor in creating jobs after the war.

The majority of such organizations are almost completely devoid of reserves—cash or otherwise. Their earnings have been plowed back for inforced expansion, renegotiated, or taxed away to the point that setting aside any "seed money" has been impossible.

The Postwar Need

But postwar America will need those companies; it will need their inventive abilities and organizational genius; it will need them to provide jobs for present labor and returning servicemen. However, it is doubtful if any appreciable amounts of capital can be attracted to these companies—the very ones who will most need capital—right after the armistice. Investment in such organizations will be too risky, and it is felt that such capital as can be attracted would, by its very source, restrict and hamper the bold planning which has characterized the companies. This, though, would almost be worse than having no capital at all, for management must be free to plan boldly.

We believe our own company offers a good example of this type of bold planning in the very program we have set up to solve the termination-pay and post-conversion problems. We realize full well that our actions will be criticized—as they have been in the past when, in our desire to beat production schedules, we anticipated potential contracts to the point that we were ready to produce, instead of merely ready to get started to produce, when the procurement agencies finally gave the go-ahead signal.

In setting up our post-conversion reserves we have acted in the belief that, following cancellation, it will take us two months to complete cancellation inventories, dispose of surplus materials, and convert equipment to already-planned postwar uses. Here again, our own plans may not be suitable for all companies, but they do furnish a tangible example which can serve as a basis for setting up nationwide plans.

As has been noted, we believe it will be necessary to release 60 percent of our employees. The remaining 40 percent will be kept on the payrolls for a 32 to 40 hr. week to take inventory, move surplus materials, convert equipment, and produce such items as can be sold immediately.

The 40 percent consists of our key men and women. Their wages can be paid from such meager reserves as the

company has been allowed to set up, by the small anticipated production, and by contract cancellation charges not immediately obtainable but immediately recoverable under V.T. loan agreements.

The production ball then must be started rolling, and to insure the ability to meet payrolls, the company has set up post-conversion reserves. It should be pointed out that our plans consider the first two months after cancellation as the conversion period; the third, fourth, and fifth months make up the post-conversion period. The post-conversion reserves, then, are in an amount to provide a payroll for the 40 percent of employees for 13 wk. at 32 hr. per week at today's wage scale and with salaried employees to be paid proportionately.

Figures on Reserves

Here is how the two reserves would work out, using assumed figures of 1,000 employees and average wages of 90c. per hour:

Termination pay reserve: 60% of 1,000 employees—600 employees at $10 per wk., for 9 wk.	$54,000
Post-conversion pay reserves: 40% of 1,000 employees—400 employees at 90c per hour for 32-hr. wk., for 13 wk.	149,760
Total reserves	$203,760

If the amount of the excess profits postwar credit is clearly made available for such uses upon cancellation of contracts, there might be some reason for deducting that amount in making the computation above. It is more likely, though, that the excess profits postwar credit will be used for materials, fixed charges, and other purposes besides wages.

The company realized that both funds it has set up are, if anything, too small. But they have been kept small intentionally in order to forestall any argument that we might be "asking for the moon," or that they are too high per person. It should also be carefully noted that no request has been made for reserves to cover purchase of materials, or to cover dividends, overhead, or capital investment. Nothing is sought but a means to insure wages.

Government, too, can be assured that such reserves would be used for the purposes specified by having them placed in escrow, or otherwise earmarked. If the reserves were allowed and then it was later found, for reasons impossible to foresee now, that they could not be utilized for the announced purpose, it should be the government's privilege to tax the funds, using the tax formula existing in the year during which the reserves were set up. Such a procedure would prevent industry from setting up reserves higher than necessary and would, in effect, recapture the tax which might be avoided by setting up higher-than-necessary reserves.

The three months established as the post-conversion period certainly represent a minimum of time. Scott Aviation Corp. is sure enough of its postwar position to know that if it can get through those months without borrowing it will then be well on the way to recovery—and employee rehiring.

Prime objective of both termination pay and post-conversion reserves is to avert, as much as possible, the reconversion disturbances of employment. The company feels that its efforts in that direction should be encouraged if this country's potential production is to remain in the hands of private industry. Speedy conversion from war to peace—possible with us because we know what we will produce—is imperative, just as imperative as was the speedy conversion from peace production to war production.

Intelligent government handling of the reserve problem can be the biggest single factor in keeping unemployment at a minimum so that private enterprise can function freely and swiftly.

Industry *can* do the job. The government *must* make it possible or face the inevitable and unpleasant consequences.

Northrop's Plan

(*Continued from page* 109)

need their help. It is, therefore, our duty to get ready to assist them in re-locating themselves when we have to release them to postwar employment.

The Northrop Plan faces this problem realistically and, we believe, humanely. We are already preparing an inventory of skills and trades possessed by our employees. Then when the time comes that other industries are seeking personnel, we will be able to bring these prospective employers and thousands of our employees together for their mutual benefit. We hope that, through our help, the transition for many will be but a week-end affair—that they will finish with us on a Saturday and start their new jobs the following Monday.

Studies made to date indicate that the employee re-location problem will not be as great as it might first appear, for employment applications and other company records provide most of the required information on the individual employee. Nor will locating jobs be as difficult as might first be thought. The Committee for Economic Development, for example, is gathering data on postwar employment and has already found that a surprisingly large number of the varied industries under study will have to increase their employment far beyond their prewar requirements in order to meet postwar demands for consumer goods.

Many Job Contacts

Northrop subcontractors, too, will provide a large and widely varied group of contacts from, and through, whom personnel requests can be anticipated. Most of these organizations were in business prior to the war and took on subcontracts because the war had killed their former business. As a matter of fact, many present Northrop employees came from such organizations, and it is expected that as the subcontractors go back to peacetime production, the workers will go back to "the old stand."

Still another source of job contacts comes from more than a thousand vendors from whom the company now purchases supplies, tools, stock, and equipment. Virtually all were established before the war; most of them will have postwar personnel needs equal to, or greater than, their present requirements.

There are, of course, many other sources which will be contacted and circularized regularly so that our release of personnel can be made as orderly as possible, thus avoiding "dumping" employees into a glutted labor market to shift for themselves.

In many ways the Northrop organization is an ideal testing ground for this employee re-location plan. Prior to wartime expansion we had approximately 2,500 employees; today the figure is around 10,000. Men and women who have gone into military service, and others to whom the company feels an obligation, total about 2,000. It is expected that about half of them will want to return to the company, although the figure may reach as high as 90 percent. Assuming it will be the first figure, present personnel, plus returning service men and women, would total 11,000. If the company's hopes of going no lower than its prewar level are borne out, it will be able to employ approximately 2,500 people.

Simple subtraction then shows that excess personnel would total approximately 8,500. However, of that number some 3,000 are women, most of whom are believed will want to return to their homes or former occupations. Another 250 are students, many of whom will go back to school. Still another 900 are men who came out of retirement and who will want or need a long rest or permanent retirement when the war is won. Another group of 2,500 is made up of men from selling and service occupations which did not offer full-time employment when the war started. Most of these men will probably return to their more lucrative former positions, bringing down

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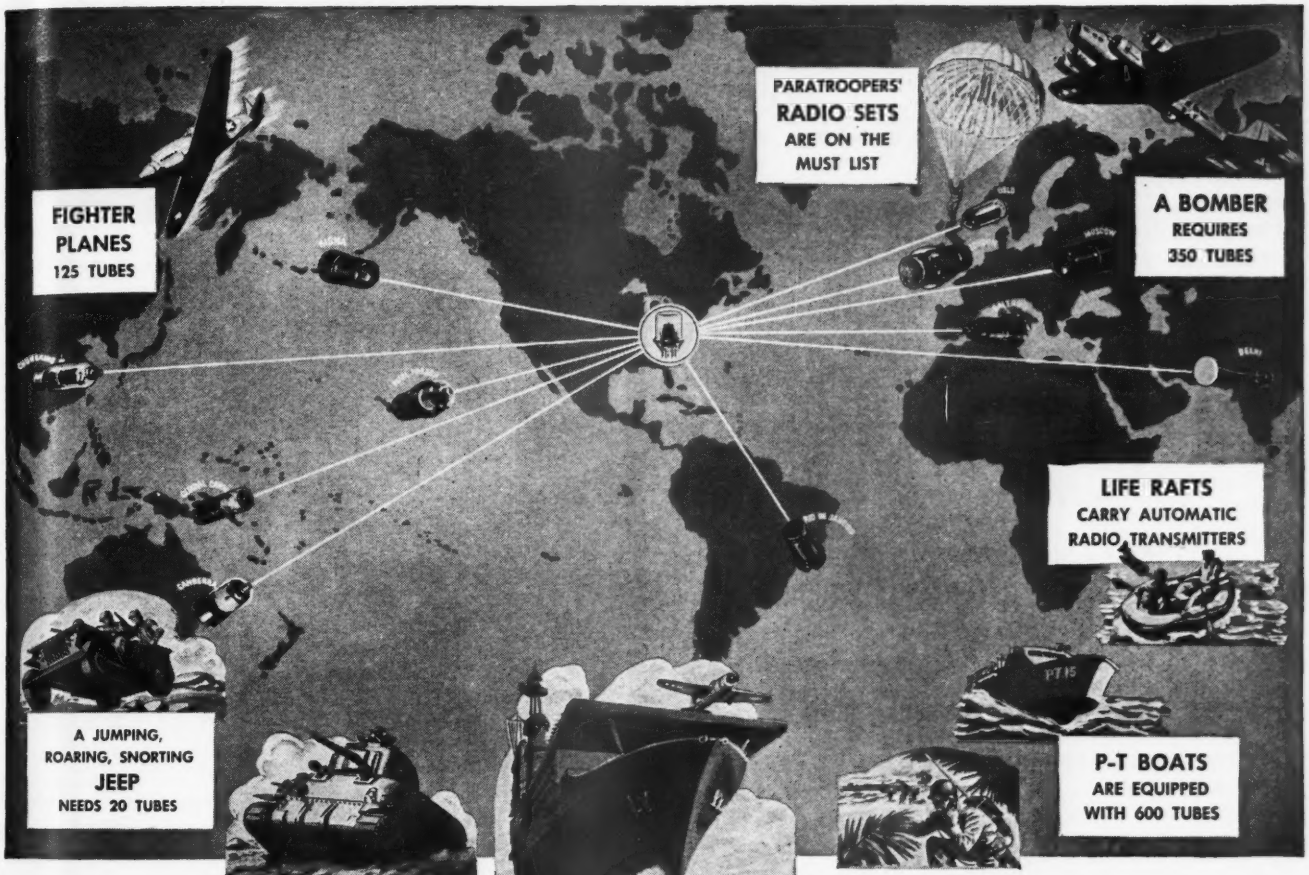
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P-T BOATS ARE EQUIPPED WITH 600 TUBES
A LARGE TANK USES 60 TUBES
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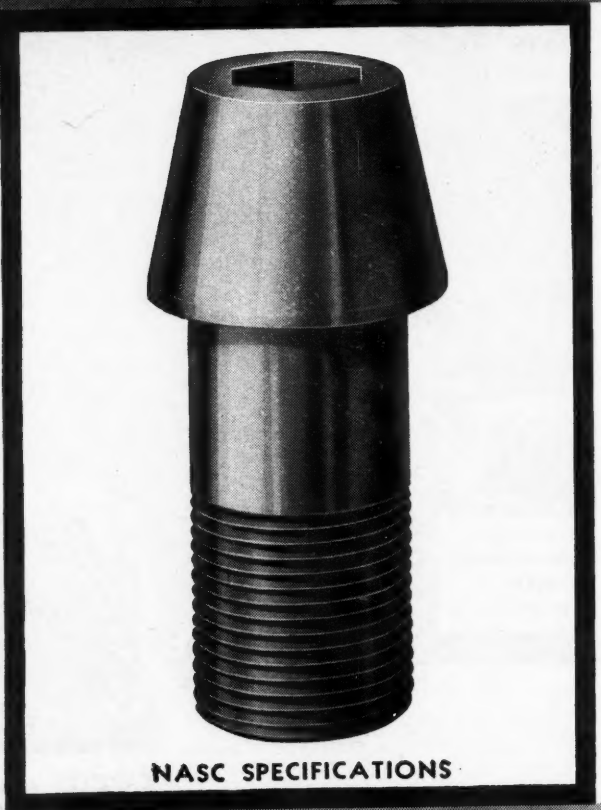

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to 6,650 the excess personnel for whom the company feels it will not be called on to provide peacetime employment.

Thus machinery must be set up to find employment for only 1,850 out of a wartime peak of some 11,000. The figures cited are approximations, because the picture changes from month to month.

Like most other aircraft companies, the Northrop plants have required a wide variety of skills, since it has turned out experimental designs, mass-produced its own and other companies' planes, manufactured parts for others to assemble and worked in several metals, woods, and plastics. The ratio of skills involved will, it is believed, be paralleled in most other organizations.

First step in developing the Northrop Plan, then, was the design of a tabulating machine form to which could be transferred all the data required on each employee. Special attention was paid to first and second skills—particularly with respect to peacetime employment—and geographic location of the workers' prewar homes. This latter information is given since it is indicated many employees will want to return to their old homes, also because it is anticipated that many calls for workers will come from these areas.

One of the most significant features of this tabulating system is its speed, for the modern mechanical sorting devices can riffle through 10,000 cards and collate given skills and locations within an hour. For example, the names of all employees skilled in bricklaying, regardless of their Northrop occupation, can be picked out of the entire personnel list in some 25 min.

This matter of speedily getting prospective employer and employee together is important, for unless jobs can be found quickly potential employers will not use the system. And unless the plan works fast enough to avert expensive delays, employees will not depend on it and will be prone to leave their wartime jobs earlier than they might otherwise.

Under the plan, office quarters will be furnished to representatives of concerns seeking employees and releasable Northrop employees will be granted opportunities to apply for jobs.

By listing skills it should not be inferred that the plan will in any way limit the employee's choice of a postwar occupation. Nor should it be inferred that the company plans to operate an employment agency. The plan does contemplate, however, giving every possible service in bringing job openings to those Northrop workers who will find it of value.

We hope the plan will help bridge the gap between wartime and peacetime employment for thousands who will want and need such assistance. By bridging that gap we hope we can remove uncertainty for our people and make it possible for them to continue building, right up to the last day of fighting, the planes our Air Forces must have to win the war.

Just how serious this problem of assuring war industry personnel of all possible help in a quick transition from war to peacetime work is underscored by the growing number of totally unfounded rumors which have recently swept West Coast aircraft and shipbuilding plants. Fanned by irresponsible elements seeking to capitalize on unrest, some rumors gained such circulation that it was necessary for management to recognize and deny them.

Cancellation of some contracts—largely of a minor nature and due to dwindling need for certain products being replaced by newer materials—have brought about some layoffs. These instances were such a reversal of usual wartime employment conditions that they "made news" and were widely publicized. Coming on the heels of the rumors, these stories provoked considerable uneasiness among war plant employees. More such announcements are bound to appear, and it is entirely possible they may precipitate new waves of job severances—severances that may seriously impede aircraft production and disrupt long-planned military operations. This, in turn, could easily cause military upsets and prolong the war.

It is to counteract such uncertainty that the Northrop plan has been developed, and it is presented here in the hope that other organizations—both in and out of aviation—may thus be influenced to develop similar programs aimed at achieving an orderly release of excess personnel to postwar employment.

IAS Annual Papers

(*Continued from page* 114)

a cycle with prospects of sounder developments and more efficient uses in the future. Present status of wood has bogged down somewhat due to lack of fundamental design data, experienced personnel, and necessary time. Despite serious disadvantage of not being able to hold wood to close tolerance, Hess predicted a large share of wood construction in postwar cargo and small passenger planes, helicopters, and gliders.

Albert A. Arnhym in his paper on *Soundproofing of Military Aircraft,* declared that minimum noise design, if started on the drawing boards, would greatly improve over-all plane performance. Such primary soundproofing must be followed by secondary soundproofing with installation of suitable materials for proper crew comfort. At least ¼ to ½ percent of gross weight should be allotted this extra equipment for good results, he declared.

Chief point made in Dr. Hugh DeHaven's work, *Structural Causes of Injury in Light-Aircraft Accidents,* is the need for proper placing of seats, belts, and cabin structures to avoid the ever-fatal head injuries and abdominal wounds.

Presaging arrival of radiant heating for the general public, F. W. Hutchinson, speaking for his co-author on *Radiant Energy Exchange as a Factor in Airplane Cabin Heating,* said panel heating offered a plausible solution to the special problems of aircraft heating.

Directional Stability of Flying Boat Hulls During Taxiing by John D. Pierson, presented stability curve data on small prototype hulls tested in the experimental towing tank at Stevens Institute of Technology. Data was given for designers confronted with takeoff problems of overloaded flying boats, especially in cross-wind operation. Regions of severe instability on the basic hull forms was shown on detailed stability charts.

Other papers presented at the Production and Design sessions included: *Demagnetization During Magnetic Particle Inspection,* by M. Mages; *Aircraft Industry French Technique,* by Alex M. Gorfin; and *Impact Resistant Windshield Construction,* by G. L. Pigman.

Aerodynamics

Principles of aero-economics as a guide to future aircraft development, making maximum use of new designs and improving utility of old models, was offered by James B. Kendrick in his *Aero-Economics.* Assuming that every design feature must be beneficial to over-all utility of plane, the author developed simple formulas based on rate per ton-mile to show effects of drag, propeller efficiency, fuel consumption, additional horsepower, maximum lift, stability, and safety on payload and range under various takeoff conditions.

Basis of Neil P. Bailey's *The Thermodynamics of Air at High Velocities* is the so-called Mach Number, which simplifies difficult problems in compressible flow, nozzle and diffuser friction, entropy change, and energy conversion efficiency in nozzles, as well as shock wave theory. As was true of most papers in the aerodynamic session, *Fuselage Influence on the Airflow at the Propellers of a Multi-Engine Aircraft in Yawed Flight* by R. P. Harrington and Victor Zadikov involved

Alan G. Binnie

Frederick Flader

R. H. Prewitt

L. Weiss

considerable higher mathematics, mostly ellipsoidal harmonics. As the title suggests, however, the aerodynamic effect of fuselage interference on propellers is investigated with respect to angle of attack of a blade element. It was found under certain conditions that angle of attack increments could change the angle of attack of element by 50% for certain blade positions.

An analysis of profile drag of high solidarity airfoil grids based on theoretical applications of Squire and Young and experimental investigations of NACA 0012 airfoils was presented in *Drag of Airfoils in Grids of High Solidity,* by John R. Weske. *Airfoil Theory for Flows of Variable Velocity* by Rufus P. Isaacs was another highly mathematical treatise with practical applications in the field of rotary wing aircraft.

Latest research on dive brakes, particularly their effect on drag and plane stability, was presented by Philip G. Blenkush, Raymond F. Hermes, and Merle A. Landis in their work, *Effect of Dive Brakes on Airfoil and Airplane Characteristics.* Data taken from double split flap type brakes on a small model at the University of Detroit wind tunnel showed forward installations reduce maximum lift as well as giving minimum drag.

In a dual demonstration of charts and hodograph models by Hans Kraft and Charles G. Dibble, the linearization and exact solution of many difficult differential equations of compressible flow were explained. Their paper, *Some Two-Dimensional Adiabatic Compressible Flow Patterns,* was based on well known methods of solution but was intended as an aid to aircraft as well as turbine and compressor designers in picturing physically complicated compressible flow patterns.

Other papers given at the Aerodynamic session included: *The Influence of Structural Deformation on Aerodynamic Characteristics of the Airplane,* by Alexander Flax; *Investigation of the Wing-Wake Frequency with Application of the Strouhal Number,* by Zbigniew Krzywoblocki; and *Instrument for the Exploration and Measurement of Areas of Vorticity,* by John J. Jackliteh, Jr.

Air Transport

If full potentialities of traffic volume are to be realized, expanding airports must take definite steps towards solving inescapable traffic control problem, M. G. Beard declared in *Traffic Control Problems for Future Airports.* Indicating the seriousness of the problem, he cited the fact that on Dec. 1, 1941 LaGuardia Field had, in 1 hr., 248 scheduled departures and arrivals with a peak load of 40 plane movements. Proposed solutions are proper runway design—preferably a tangential runway system—and an automatic traffic control system using radio and radar equipment.

In *The Correlation of Aircraft Takeoff and Landing Characteristics with Airport Size,* A. L. Morse, reviewing a report on same by the CAA declared that although the work is fairly old, it presents a reliable solution of the problem. Most of the data was obtained from some 560 photographs of actual takeoffs and landings under conditions including different altitudes, cross-wind, and weather.

Concerned primarily with the psychophysiological aspects of a new pilot training technique, *Daylight Training of Pilots for Night Flying,* by J. G. Beebe-Center, L. Carmichael, and L. C. Mead, reported on simulated night flying conditions through use of red and green filters. Keynote of Charles S. Whitney's paper on *Aircraft Hangars and Terminal Buildings* concerned development of new type long-span reinforced-concrete shell construction for use on large blimp and dirigible hangars. Advantages named include low maintenance cost, fire resistant construction, applicability to any design situation and economic feasibility in foreign countries.

Materials and Structures

Use of natural aging alloys in aircraft production should be of great import, especially when high temperature and quench treatment is eliminated, according to Hiram Brown in *High Strength Casting Alloy With Reaging Properties.* Ability to regain high strength comparable to heat-treated alloys by aging naturally from temperatures near 1,000 deg. F. without warpage and stress concentrations gives this type alloy great possibilities, he said.

William S. Murray pointed out in his report, *Indium in Aviation,* that the greatest contribution to this metal to industry has been development of superior, hard surface bearings with another important use in stabilizing non-ferrous metals.

Powder metallurgy, although particularly adapted to production of bearings and other small engine parts, is making slow progress in other fields because of limitations in design, materials, methods, manufacturing facilities, and costs, Carl Claus reported in *Parts from Metal Powders.* New applications require careful study of experienced technicians and, hence, will not lead to sudden changes of manufacturing practices in favor of the sintering method.

Structural designers will be heartened by results of a survey of recent wrought aluminum alloy developments, according to D. A. Lawless' paper on *New Wrought Aluminum Alloys for Aircraft and New Temper Modifications of Present Alloys.* Ultimate tensile strengths ranging from 65,000 to 75,000 psi. are available in both new type alloys and artificially aged 24ST stock. Most notable of the former group are modified dural and intermediate zinc, with corrosion resisting properties. Modifications of the popular 17ST alloy, Lawless pointed out, will greatly improve machinability without affecting other of its properties.

In presenting his article, *Three-Dimensional Analysis of Engine Mount Rings by a Strain Energy Method,* Charles E. Mack, Jr. developed general

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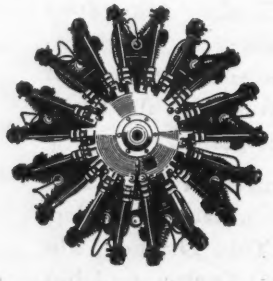

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equations for application on any circular engine ring mounting problem involving non-distributed loads and bending. Explaining that methods used to obtain results here were known to most airplane designers, Fletcher N. Platt outlined and illustrated with example his short-cut system of arriving at the all-important preliminary wing design gages of structural elements and weights in *Preliminary Structural Analysis and Weight Investigation of Wings.*

A new formula for determination of the resistant bending moment of magnesium alloys was advanced in *Flexural Strength in the Plastic Range of Rectangular Magnesium Extrusions,* by F. A. Rappleyea and E. J. Eastman. Differences of yield strength in compression and tension invalidates the classical bending formula and requires more accurate means of predicting properties. New formula presented was in close agreement with experimental results. Along the same line, William R. Osgood provided material on bending moment beam curvature relations on the assumption that stress-strain conditions are the same in pure tension and compression for bending loading. This paper was titled *Plastic Bending.*

Buckling Loads of Beams or Plates on Continuous Supports, by Edward Saibel, offered advantages over the conventional Rayleigh-Ritz method of solving buckling plate problems.

Also presented at the Material & Structures sessions were: *Roll-Formed Section of 24S and Alclad 24S Aluminum Alloy,* by Thomas H. Huff; also *Engineering Applications of Design-Strengthened Materials,* by Dimitry E. Olshevsky and Richard S. Smith.

Meteorology

Among the meteorology papers were *The Vertical Structure of the Atmosphere as Shown by Correlation Studies,* by G. W. Brier, and *Methods of Estimating or Determining the Heights and Motions of Clouds,* by Charles F. Brooks. Brier showed the relationship between variations in the layer densities of the atmosphere with computations of correlation coefficients and pressure differences based on studies of Dines, Schedler, and Haurwitz. Various schemes for determining cloud heights and velocities, including use of stereoscopic rangefinder, theodolite, and nephoscope, were given in the Brooks paper.

Both articles, *Causes of Nighttime Thunderstorms Over the Middle West,* by Donald M. Crowley, and *Contribution to Nocturnal Instability by Advection,* by Lynn L. Means, bore out the close connection between warm air advection in lower atmosphere layers and nocturnal maximum occurrence of thunderstorms in the Middle West. Crowley said that, contrary to general opinion, the low pressure Rocky Mountain area does not produce nocturnal disturbances over the Plain States.

Remaining papers read before Meteorology session were: *An Approach to Quantitative Forecasts of Precipitation,* by A. K. Showalter; *On the Significance of Correlations of Large-Scale Circulations and Computations of the Correlation Coefficients,* by Irving I. Schell; *Pressure Changes Due to Vertical Motion,* by H. A. Panofsky; *A Method of Preparing Prognostic 24-hr. 10,000-ft. Charts,* by James E. Walsh; *The Collection and Use of Meteorological Data,* by S. P. Ferguson; and *Transport Theory of Ozone Variation,* by Fred W. Decker, Conrad P. Mook and J. Richard Smith.

Power Plants and Propellers

In his piece on *Aircraft Powerplant Fire Protection,* H. L. Hansberry declared good fire protection is accomplished by using welded steel tube and sheet construction in place of aluminum alloy sheets and monocoque structures around engine nacelles, also through installation in planes of fire detectors and automatic crash extinguishing systems.

Maximum effect of the vibration absorber is found to occur with minimum absorber and main system damping, optimum tuning, and maximum mass ratio, Ralph J. Harker reported in *The Theory of the Centrifugally Tuned Vibration Absorber.* As an aid incorrelating clearly the variables involved, a chart was presented of main system response peak frequency, amplitude and absorber tuning, damping, and mass ratio. In his survey, *Propeller Design Requirements,* H. M. McCoy said the full-feathering propeller is the most valuable single contribution to multiengine airplane flying safety in recent years. With a 10 percent increase in engine ratings already achieved with improved propeller governing, he predicted another future 10 percent rise.

Also presented at Power Plants & Propellers session were: *Stability of a System Acted Upon By a Plurality of Co-Acting Automatic Controls,* by C. W. Chillson, R. J. Kochenburger, and P. J. Quinn; and *Application of the Variable Ratio V-Belt Principle in the Design of a Constant Speed Propeller,* by Lloyd H. Leonard.

Radio and Instruments

James George's *Development of Stall Warning Indicators* reported on two types operating on the predetermined angle of attack principle, both of which will be available in the near future. A third model, which will perform under icing conditions, he said, is still in the design stages. Problems of accessibility, serviceability, vulnerability, and installation in wartime have caused switching from hydraulic to electrical-mechanical control systems in aircraft, asserted Richard M. Mock in his paper *Airplane Remote Controls and Automatic Controls.*

In a joint paper on *The Electronic Turbo Regulator,* W. H. Gille and H. T. Sparrow described an electronic unit which maintains—independent of ambient pressure and temperature—any fixed carburetor inlet pressure, limits manifold pressures to safe maximums, and prevents overshooting of these pressures.

Other papers given at this session included: *Flight Research Instrumentation of the Single-Seat Fighter,* by Stephen B. Elggren; and *Measurement of Rate of Flow by Means of an Oscillating Vane,* by P. Weiller, Victor E. Carbonara, and Arleigh Van Nostrand.

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